Did the War on Terror Ignite an Opioid Epidemic?*

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Abstract

Grim national statistics about the U.S. opioid crisis are increasingly well known to the American public. Far less well known is that U.S. war veterans are at ground zero of the epidemic, facing an overdose rate twice that of civilians. Post-9/11 deployments to Afghanistan and Iraq have exposed servicemembers to injury-related chronic pain, psychological trauma, and cheap opium supplies, each of which may fuel opioid addiction. This study is the first to estimate the causal impact of combat deployments in the Global War on Terrorism on opioid abuse. We exploit a natural experiment in overseas deployment assignments and find that combat service substantially increased the risk of prescription painkiller abuse and illicit heroin use among active duty servicemen. War-related physical injuries, death-related battlefield trauma, and Post-Traumatic Stress Disorder emerge as primary mechanisms. The magnitudes of our estimates imply lower-bound combat exposure-induced health care costs of $1.04 billion per year for prescription painkiller abuse and $470 million per year for heroin use.

Keywords: war deployments; combat exposure; opioids; prescription drug abuse; heroin

JEL codes: I1, I12, H56

1. Introduction

> *"U.S. military veterans, many of whom suffer from chronic pain as a result of their service, account for a disproportionately high number of opioid-related deaths. Veterans are twice as likely as the general population to die from an opioid overdose."*
>
> – Council on Foreign Relations (2018)

The U.S. opiate epidemic has intensified rapidly over the last two decades. Between 1999 and 2016, opioid-related mortality rose over 500 percent (Centers for Disease Control and Prevention 2017), with the total number of deaths attributable to opioids quintupling the number of U.S. servicemembers killed in the Vietnam War and all subsequent U.S. conflicts combined (Congressional Research Service 2018). While fentanyl- and heroin-involved mortality now comprise the largest share of opioid-related deaths, 40 percent of overdoses are due to prescription drugs (Seth et al. 2018; Hedegaard et al. 2017). Nearly 2.6 million Americans suffer from opioid use disorder (SAMSHA 2016).

While grim national statistics about the "worst drug overdose epidemic in history" (Ahmed 2016) are increasingly well known to the American public (National Opinion Research Center 2018), far less well known is that combat veterans constitute a population at ground zero of this crisis. Mortality rates for opioid-related poisonings are 1.3 to 2.0 times higher for veterans as compared to civilians (Bohnert et al. 2011; Axelrod 2013), and this overdose crisis is deepening.[1] Opioid-related mortality among veterans rose from 14.47 persons per 100,000 in 2000 to 21.08 persons per 100,000 in 2016 (Lin et al. 2019). In addition, the opioid abuse prevalence rate among veterans was over seven times higher than for civilians (Baser et al. 2014).[2] Following major combat operations in Afghanistan and Iraq, there was a 55 percent increase in the rate of opioid use disorders among veterans (VA Opioid Prescription Policy, 2015). In Fiscal Year 2016, approximately 68,000 veterans were treated for opioid addiction (VA Opioid Prescription Policy, 2015), a condition that contributes to a substantial increase in public health care costs ($31,022 per veteran in 2018$) (Baser et al. 2014).

[1] These comparisons reflect age- and gender-adjusted mortality.
[2] Baser et al. (2014) compare those participating in the Veterans Health Administration public health plan to non-veterans in commercial health care plans.

The extent of the veteran opioid epidemic is almost surely understated. Military personnel often eschew treatment due to significant social stigma in their ranks (Teeters et al. 2017). Moreover, veterans often live in medically underserved areas with limited access to psychotherapy (Teeters et al. 2017),[3] leaving many undertreated and at risk for progression to severe addiction and overdose (Miller et al. 2015).

Next to nothing is known about how post-September 11 U.S. war policies — which resulted in 5.4 million deployments of nearly 2.8 million servicemembers to Iraq and Afghanistan (Wenger et al. 2018) — contributed to the veteran opioid epidemic. War injury-induced chronic pain, lax monitoring of opioid prescriptions by Veterans Health Administration (VHA) providers, combat-related psychological trauma, and exposure to cheap opium supplies during war deployments have placed post-9/11 combat veterans at substantial risk for opioid abuse and mortality.

Approximately 45 percent of veterans suffer from chronic pain (Clancy 2014; Sandbrink 2017), a rate three to five times higher than civilians (Toblin et al. 2014; Johannes et al. 2010). Up to 70 percent of war injuries to post-9/11 combat veterans are due to improvised explosive devices (Schoenfeld et al. 2013), a common tactic employed by US enemies in Iraq and Afghanistan. As a result of war injury-induced pain, the rate of opioid prescription receipt is 15 percentage-points higher among military personnel than among civilians (Toblin et al. 2014). Nearly half of all veterans diagnosed with non-cancer-related pain were prescribed an opioid (Edlund et al. 2014), and many of these prescriptions were for long-term use, with 57 percent receiving an opioid prescription for more than 90 days (Edlund et al. 2014).[4] Among post-9/11 Army veterans, approximately 34 percent were prescribed opioids to treat pain, with long-term opioid treatment most commonly prescribed for pain related to the back and neck as well as peripheral/central nervous system problems (Adams et al. 2018).

While legitimate opioid prescriptions generated significant health benefits, military health professionals worry that the massive increase in opioid prescriptions following combat deployments contributed to opioid addiction and mortality among post-9/11 combat veterans (U.S. Department of Defense 2017; National Center for Complementary and Integrative Health

[3] Teeters et al. (2017) also argue that dual diagnoses of PTSD and opioid addiction are quite difficult.
[4] A case study of one infantry brigade estimated post-deployment opioid use of 15 percent (Toblin et al. 2014).

2015; Becker et al. 2009).[5] These health risks were especially acute for those prescribed daily opioid dosages of over 50 mg to treat long-term chronic pain (Bohnert et al. 2011). Indeed, among the estimated 6,485 veterans treated by the VHA who died of opioid-related causes between 2010 and 2016, rates of opioid prescribing by the VHA were extremely high (Lin et al. 2019). Risks may have been further amplified by the lack of VA regulations requiring providers to access state electronic Prescription Drug Monitoring Programs before prescribing a controlled substance to patients (General Accounting Office 2018; Gellad et al. 2018; Radomski et al. 2018),[6] earning the ire of high-profile policymakers (McCain 2017).

In addition to chronic pain and lax regulatory practices, the psychological consequences of traumatic war experiences may have also contributed to veteran opioid abuse. Post-Traumatic Stress Disorder, a condition with which nearly one-fifth of active-duty servicemembers have been diagnosed (Tanielian and Jaycox 2008; Sabia and Skimmyhorn 2019), is associated with increased risk of opioid addiction (Seal et al. 2016; Shiner et al. 2017; Meier et al. 2014).[7] Abuse of prescription painkillers and illicit use of natural (heroin) and semi-synthetic (fentanyl) opioids may serve as a coping mechanism for veterans' psychological pain.

Finally, access to cheap opium sources during war deployments may have exposed deployed servicemembers to increased risk of opiate addiction (Robins and Slobodyan 2003). Reports from top military commanders suggest that post-9/11 deployments to Afghanistan, and occasionally Iraq, increased the ease with which combat veterans could access heroin (Robert Weiner Associates 2009).[8]

Given these risk factors, the Department of Defense has speculated that the Global War on Terror (GWOT) may have contributed to opioid addiction among post-9/11 veterans.

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[5] This sentiment is reflected in Senator John McCain's (R-AZ) introduction of the Veterans Overmedication Prevention Act (VOPA). VOPA would require the VA to document and report VA-prescribed medications for servicemembers who died via completed suicide or accidental poisoning.

[6] The highest rate of overdose occurred for veterans who were prescribed a daily opioid dose of 50 mg or more. Estimates from a CBS news special investigation of VHA data in the five most populous veteran states found that veterans were 33 percent more likely to die from narcotics poisoning than their comparable non-veteran counterparts. This report is available here: https://www.cbsnews.com/news/veterans-dying-from-overmedication/

[7] There is also evidence that combat service-induced psychological harm may increase risk of subsequent binge drinking (McFall et al. 1992; Price et al. 2004) and cigarette use (Cesur et al. 2016), perhaps as a coping mechanism.

[8] Peer effects among combat units could be an additional pathway through which opioid abuse may occur. There is evidence of unit-level peer effects in the use of VDC and educational benefits (Murphy 2018). The illicit sharing of prescription medications among close-knit comrades could result in increases in opioid abuse.

"[Opioid abuse] may relate to deployment effects, such as injuries, combat exposure, and mental health conditions." (U.S. Department of Defense 2017)

Despite this assertion, no study has examined whether post-9/11 combat deployments causally ignited an opioid epidemic among U.S. veterans. To our knowledge, this study is the first to do so. We exploit a natural experiment in the assignment of active-duty male members of the armed forces on overseas deployment duties to identify the causal impact of combat service on opioid abuse. Our results provide consistent evidence that combat assignment substantially increases the risks of prescription painkiller abuse and illicit heroin use. The magnitudes of our estimates imply lower-bound combat exposure-induced health care costs to the Department of Veterans Affairs of $1.04 billion per year to treat prescription opioid abuse and $470 million per year to treat heroin use.[9] These costs exclude non-health costs as well as the costs of increased opioid-related mortality.

Descriptive evidence suggests that combat-related physical injuries, which may have resulted in initially legitimate opioid prescriptions, as well as war-related psychological trauma, are primary mechanisms at work.

2. Background

2.1. Opioids and Chronic Pain

Opioids — which include opium, its derivatives such as heroin or methadone, and synthetic and semi-synthetic opioids[10] — act on receptors in the brain and spinal cord to reduce

[9] These estimates were obtained using data from Wenger et al. (2018) on the number of active duty deployed servicemembers to Iraq and Afghanistan (2.1 million). According to our estimates from the DOD data, 51.5 percent of all deployed servicemembers were exposed to enemy firefight fight (Table 1B). Taken together with the per-veteran public health care cost of treating opioid addiction from Baser et al. (2014) ($31,022 in 2018 dollars), and the marginal effects reported in columns (2) and (3) of Table 4A, our back-of-the-envelope cost calculation is (2.1 million)*($31,022)*(.031)*(.486) for prescription painkiller abuse and (2.1 million)*($31,022)*(.014)*(.486) for heroin use. We assume that those who abuse opioids seek (VA paid-for) treatment in steady-state. As noted, these figures correspond to conservative lower bound estimates of the effect of engaging the enemy in the firefight on the potential treatment costs of prescription painkiller misuse in the Department of Defense Health Related Behaviors survey. Estimates obtained from the Add Health suggest much higher costs. Our estimates in column (2) of Table 3 suggest that combat zone deployments (rather than simply exposure to firefight in combat zones) lead to approximately 170,000 active-duty members of the armed forces abusing opioids annually with the ninety-five percent confidence interval of the associated health care costs ranging from $930 million to $9.6 billion.

[10] Among the most commonly used synthetic and semi-synthetic opioids include Demerol, Fentanyl, Methadone, Oxycodone (OxyContin, Percocet), and Hydrocodone (Vicodin).

the intensity of pain. Among the side effects of opioid consumption include slowed breathing, which can increase the risk of overdose if the dosage is sufficiently high, and an addictive high caused by censors in the brain that induce euphoria.

The pain-relieving properties of opioids have been known for centuries, including among military personnel. During the Civil War, the Union Army treated war injury-induced pain with 79,000 kilograms of opium powder and nearly 500,000 opium pills (Schiff 2002), earning the nickname "God's own medicine" (Booth 1996).[11] The addictive nature of opium, particularly in the form of morphine, was also well known.[12]

While the use of opioids to treat pain in hospital settings has been historically quite common (Jones et al. 2018), opioid-based treatment for chronic pain in outpatient settings is a relatively new phenomenon (Johannes et al. 2010), representing both a clinical and public health challenge (National Research Council 2011). Opioid prescriptions rose substantially from the 1990s to early 2010s (Compton and Volkow 2006; Rosenblum et al. 2008), before falling to around 169 million by 2015 (NASEM 2017). Veterans Affairs providers followed a similar pattern, with opioid prescriptions rising by 77 percent between 2004 and 2012 (Mosher et al. 2015) before falling substantially thereafter (U.S. Department of Defense 2017).

The rapid increase in opioid prescribing during the 1990s and 2000s has been attributed, in part, to (i) a failure of medical science to accurately assess the addictive properties of synthetic and semi-synthetic opioids[13], (ii) advocacy by the American Pain Society and government health agencies, including the Veterans Health Administration, to treat pain as the "fifth vital sign,"[14]

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[11] In addition, opium use was commonly used to treat menstrual pain during the 19th century (Aurin 2000).

[12] Morphine addiction among Union and Confederate servicemen was sufficiently common to be called "soldier's disease" (Schiff 2002).

[13] Uncertainty over the addictive properties of synthetic and semi-synthetic opioids began in the early 1980s. The infamous correspondence note in the *New England Journal of Medicine* by Porter and Jick (1980) is widely considered to be the signal event which served to normalize the use of self-administered opioids in the community. The note, which concluded "despite widespread use of narcotic drugs in hospitals, the development of addiction is rare in medical patients with no history of addiction," was actually focused on the very short-term treatment of patients in a single inpatient setting. However, this correspondence was cited aggressively by those advocating opioid treatment for chronic pain, including in outpatient settings (Leung et al. 2017).

> "In conclusion, we found that a…letter published in the Journal in 1980 was heavily and uncritically cited as evidence that addiction was rare with long-term opioid therapy. We believe that this citation pattern contributed to the North American opioid crisis by helping to shape a narrative that allayed prescribers' concerns about the risk of addiction associated with long-term opioid therapy."

[14] The call for physicians to act more aggressively to treat chronic pain began in earnest in the mid-1990s when the American Pain Society advocated that physicians emphasize pain assessment during patient evaluations, claiming that pain be considered the "fifth vital sign" (Merboth and Barnason 2000; Mularski et al. 2006; Tompkins et al.

(iii) increased demand by consumers for effective outpatient pain management, and (iv) lax regulatory practices that permitted patients to doctor shop for opioid medication and pharmaceutical companies to supply pills to communities at rates far exceeding plausible medical demand.[15] These explanations are reflected in policymakers' attempts to combat the opioid epidemic, which have (with the exception of naloxone access laws) largely focused on imposing restrictions on prescription opioid access.

2.2 The Department of Veterans Affairs and Prescription Drug Monitoring

Mandatory-access Prescription Drug Monitoring Programs (PDMPs), which require that physicians and pharmacists access the prescription history of each patient via an electronic database prior to writing a prescription, have been one of the most effective policy tools to curb prescription drug abuse and opioid-related mortality (Dowell et al. 2016) and addiction (Birk and Waddel 2017; Grecu et al. 2019; Buchmueller and Carey 2018). However, VA providers have been exempted from required participation in mandatory-access PDMPs throughout the near entirety of the opioid epidemic.

In deference to protecting veterans' privacy rights, the VA was historically reluctant to share patients' prescription drug histories with state PDMPs. In March 2010, the VA Office of General Counsel issued an opinion prohibiting the VA from participating in state PDMPs unless such entities qualified as "law enforcement entities" (Silverman et al. 2014). Because the vast majority of state PDMPs are not classified as such, this rule amounted to a near-ban on VA participation.[16] During this period, the VA created the Sole Provider Program (SPP) to curb doctor shopping (U.S. Department of Defense 2017). However, prescription monitoring was generally limited to veterans identified by providers as high risk for prescription drug abuse and failed to cover prescriptions received from non-VA providers. In addition, the SPP did not require VA providers to access a patient's complete prescription history prior to writing a

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2017). The Veterans Health Administration supported this assessment, adding treatment of the fifth vital sign to its national pain management strategy in 2000, and the Joint Commission on Accreditation of Health Care Organizations quickly followed. In 2016, the American Medical Association recommended that pain be removed as a fifth vital sign.

[15] For example, in Mingo County, West Virginia, a single pharmacy in the city of Williamson, population 2,924, received 258,000 hydrocodone pills in one month from a single pharmaceutical company, Miami-Luken. This represented more than ten times the typical delivery to a West Virginia pharmacy.

[16] As of October 2018, all 50 states and the District of Columbia have some form of PDMP. Only five state PDMPs are administered by law enforcement agencies.

prescription for a controlled substance.

In February 2013, the VA lifted its ban on provider participation in state PDMPs not administered by law enforcement agencies. In its regulatory change, the VA acknowledged:

> "PDMPs will allow the VA patient population to benefit from the reduction in negative health outcomes." (U.S. Department of Veteran Affairs 2013).

While this reform *permitted* VA provider participation in state PDMPs, it did not require participation, nor did it require providers to access the electronic database. The American Academy of Family Physicians (AAFP) concluded that "this voluntary PDMP disclosure has failed to result in VA PDMP reporting necessary information to prevent misuse and diversion of prescription drugs" (AAFP 2016).

In December 2017, nearly 20 years after the onset of the U.S. opioid epidemic, the VA Prescription Data Accountability Act was enacted, mandating that VA providers participate in state PDMPs.[17] While this law represented a critical policy shift by the VA, loopholes have prevented the full sharing of information that may prevent medication shopping (U.S. Government Accountability Office 2018). An investigation by a bipartisan coalition of members of Congress, led by Representatives Michael Turner (R-Ohio) and Seth Moulton (D-Massachusetts) found that health care providers at non-military treatment facilities (MTFs) are often unable to access TRICARE beneficiaries' prescription histories at MTFs:

> "The Department of Defense (DoD) internal prescription drug monitoring mechanisms are ineffective at mitigating controlled substance abuse at civilian facilities, where nearly half of all TRICARE beneficiary healthcare treatment occurs. DoD should build a mechanism that allows seamless information sharing with the state databases." (Representatives Michael Turner and Seth Moulton, December 2017).[18]

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[17] As part of the rollout of this new initiative, the VA published geographic-specific aggregate data on opioid prescriptions from 2012 to 2017 (Department of Veterans Affairs 2018).

[18] Upon introducing legislation to close this loophole, Rep. Mike Turner stated:

> "We have identified a gap that does not require [Department of Defense] to report controlled substance prescriptions to prescription drug monitoring programs. This DoD reporting gap makes our nation's active-duty service members, reservists, their families, veterans, and retirees vulnerable to this epidemic of

Thus, important barriers in information sharing remain that might undermine attempts to identify prescription drug abuse among veterans.

While establishing an effective prescription drug monitoring program eluded the DoD throughout much of the opioid crisis, the DoD began taking other steps to curb opioid abuse. In 2013, the Opioid Safety Initiative (OSI) was established to provide a more holistic, less opioid-centered pain management strategy to veterans (U.S. Department of Defense 2017). The OSI Toolkit was designed to provide information to (i) VA clinicians with regard to best practices in prescribing opioids, identifying signs of misuse, and the range of medical and non-medical options for treating pain, and (ii) patients on safe use of prescription opioids, alternative pain management strategies, and help for addiction.

Perhaps in part as a response to the OSI, opioid prescriptions issued by VA providers fell by over 40 percent from 2012 to 2017. While the VA has often cited this decline as evidence of a more responsible chronic pain management strategy (Department of Veterans Affairs 2018), this interpretation is the subject of controversy for several reasons.

First, the reduction in opioid prescriptions to curb abuse may have the unintended consequence of reduced pain abatement for opioid users who do not suffer from addiction (Islam and McRae 2014; Fishman et al. 2004; Volkow and McLellan 2011). There is, in fact, evidence that regulations such as the OSI induce under-prescribing to avoid non-compliance with internal regulations (Turk, Brody and Okifuji 1994; Institute of Medicine 2011; Ross-Degnan et al. 2004). Additionally, individuals with long-term pain not adequately managed by analgesics may be mistakenly identified as abusers and be cut off from needed opioids (Brushwood 2003). In the absence of effective alternative pain management strategies, sharp reductions in opioid therapy may generate significant health-related trauma for veterans.[19]

Second, sudden negative shocks to prescription painkillers could induce veterans to more dangerous, and perhaps deadly, forms of opioid use such as heroin or fentanyl if these drugs are

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addiction." (Available at: https://turner.house.gov/media-center/press-releases/turner-and-moulton-legislation-shields-members-of-dod-from-prescription)

[19] The VA/DoD Clinical Practice Guideline for Opioid Therapy for Chronic Pain (Sall and Rodgers 2018) warns against sudden reductions in opioid treatment intensity as it may put those with a higher suicidal tendency at risk of committing suicide due to withdrawal. On the other hand, if prescription drugs are a "gateway" to illicit opioid consumption, it is possible that efforts at reducing opioid treatments could save lives (Compton et al. 2016).

substitutes. For instance, when OxyContin was reformulated to deter abuse, resulting in a negative shock to supply, overdoses due to heroin (Alpert et al. 2018) and fentanyl (Evans et al. 2018) rose substantially.[20]

2.3 Exposure to Opium Supply During Deployments

While greater use of prescription opioids to treat war injuries may be one path to addiction, exposure to cheap opium during war deployments may be another. During the 1990s, Afghanistan produced nearly three-quarters of the world's illicit opium supply via its domestic poppy crop (Council on Foreign Relations 2010). While the Taliban strictly implemented an Islamic law-driven ban on poppy production in 2000-2001, production again skyrocketed following the U.S led-invasion (Operation Enduring Freedom) in late 2001. Estimates show that by 2006,

> "…twenty-one of Afghanistan's thirty-four provinces were producing 94 percent of the world's supply, estimated at a pre-export value of $4 billion and equivalent to nearly 50 percent of the country's GDP**."** (Council on Foreign Relations 2010; United Nations Office on Drugs and Crime 2007)

The post-2001 increase in opium supply greatly reduced per gram opium prices such that they were often less than one-tenth their pureness- or quality-equivalent prices in major U.S. cities (McKenna 2007).[21] While United Nations-led efforts in the late 2000s and early 2010s to make Afghanistan "poppy free" have proven largely successful in a number of northern provinces including Kunduz, Takhar, Ghazni, Paktika, and Bamyan, southern supply chains in Hilmand, Kandahar, and Badghis continued to flourish (Special Inspector General for Afghanistan Reconstruction 2015).

Opium production in Iraq was much rarer than in Afghanistan, but production in Iraq began to grow in the aftermath of Operation Iraqi Freedom. Production appears to have accelerated during the period just before and during the so-called "surge" of U.S. Armed Forces

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[20] While mortality due to prescription painkillers plateaued from 2010 to 2014, fentanyl-related mortality rose by an estimated 540 percent between 2014 and 2016 (Katz 2017).
[21] This finding is also consistent with data collected as part of the Afghanistan Opium Survey (United Nations Office on Drugs and Crime 2007).

to Iraq in 2007-2008 (Cockburn 2007; Tosti 2007).

Much of the evidence on the impact of cheap opium access during deployments on opioid abuse is anecdotal in nature, coming from military commanders and imbedded reporters. A 2008 report from the U.S. Army Strategic Studies Institute concludes that the availability of cheap opium during deployments could be an important driver of abuse (Kan 2008)[22] and top military brass concurs, including former Drug Czar and retired General Barry McCaffrey.[23]

Exposure to opium supplies during war deployments is not a new phenomenon. Servicemembers deployed to Southeast Asia during the Vietnam War were also exposed to cheap opium supplies.[24] However, there are important differences between both the form of opioid addiction and possible paths to wellness for the Vietnam and post-9/11 eras. First, abuse of opioids in Vietnam was more often attributed to recreational heroin or morphine use, whereas in the post-9/11 period, opioid addiction appears to be driven largely by prescription painkiller misuse (Edlund et al. 2014). One contemporaneous study found that of 943 urine-tested servicemen, 495, or 52 percent, tested positive for opium (Robins et al. 1974).[25] Second, many attribute the relatively low rates of relapse from opium addiction treatment among Vietnam veterans to the fact that addiction often began during deployments, and the environmental shock of returning to the U.S. without "triggers" present may have contributed to relatively high recovery rates (Robins et al. 2010).[26] In contrast, many post-9/11 veterans began addictions after

[22] Kan (2008) concludes that "when peacekeeping forces have been sent to conflicts where drugs are available, they have not proven immune from succumbing to drug use themselves" and cites a 2003 Canadian Military police report stating that "the presence of cheap and available narcotics in Afghanistan may risk higher incidence of drug abuse" (Rubec 2004).

[23] At a 2009 meeting of the National Association of Addiction Treatment Providers, retired General Barry McCaffrey warned:

> "I'd be astonished if we don't see soldiers who find 10 kilograms of heroin and pack it up in a birthday cake and send it home to their mother…The second thing is (soldiers) are going to stick it up their nose and like it." (Robert Weiner Associates 2009).

[24]Opioids were not always the substance of choice for combat veterans. During the Second World War, stimulant use was pronounced because of the perceived benefits in terms of endurance and mood enhancement (Rasmussen 2011). Benzedrine (amphetamine) tablets, a common stimulant, were regularly supplied to soldiers in both the American and British military (Rasmussen 2008). Such use under stressful circumstances led to dependence and difficulty in post-service adjustment (Rasmussen 2008; World Health Organization 1957).

[25] Three-quarters of urine positive servicemembers stated that they became addicted while in Vietnam (Robins et al. 1974). Over 95 percent of those who screened positive for controlled substances admitted heroin use while in Vietnam.

[26] Some estimates suggest that only 5 percent of Vietnam era servicemembers who sought treatment for heroin addiction that began in Vietnam suffered a relapse within a year of returning home (Gupta 2015).

returning home, often after seeking treatment for war-injury induced chronic pain (Brady et al. 2009; Reisman 2016).

2.4 Drug Testing for Opioids in the U.S. Military

One policy tool to curb opioid abuse among continuing and separating servicemembers is random drug testing. The first urinalysis screening for illegal drug use in the military was carried out by President Richard Nixon in 1971 in response to elevated rates of heroin and marijuana use among those serving in Vietnam (Irving 1988; Robins 1974). Policymakers were concerned that high rates of heroin addiction among returning veterans would be both a public health epidemic as well as a political problem, dampening public support for the Vietnam War (Massing 1998). Under a policy informally known as "Operation Golden Flow," American soldiers serving in Vietnam were not permitted to redeploy to the United States until they passed a urine test that screened for the presence of opiates, amphetamines, or barbiturates. If a soldier failed a drug test, he was given five to seven days of detoxification and treatment prior to returning home (Korsmeyer and Kranzler 2009).[27]

Department of Defense Instruction 1010.1, issued in 1974, established regular random testing for the first time in the US military. Officially, it was a clinical program to identify drug users for treatment (Coombs and West 1991). While legal restrictions prohibited the military from taking disciplinary action against servicemembers who tested positive between 1974 and 1979[28], the U.S. Military Court of Appeals subsequently overturned this decision, creating the legal basis to use urinalysis as evidence in disciplinary proceedings.[29]

In August 1981, Deputy Secretary of Defense Frank Carlucci issued Department of Defense Memorandum No. 62884, which instituted a "zero tolerance" drug policy across all

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[27] The onset of the War on Drugs is often marked by Operation Golden Flow. Dr. Robert Dupont, head of the newly-created Special Office for Drug Abuse and Prevention during the Nixon Years, stated:

> "Today, people don't even connect Vietnam with the evolution of American drug policy. When Nixon declared war on drugs on January 1971 and started the first White House office, named the first White House drug czar, within 24 hours that czar was on a plane to Saigon. There was no mistaking what his priority was from the president." (Dupont 2001)

[28] *United States v. Ruiz*, decided by the United States Military Court of Appeals, found that punishment for a failed drug test violated his right to the Fourth (search and seizure) and Fifth (self-incrimination) Amendment rights. The decision prohibited punitive actions against military personnel with positive urinalysis tests (Coombs and West 1991).

[29] *United States v. Ruiz*, 1974

military branches (Pacula et al. 2017).[30] Positive drug tests, including for heroin, were referred to a court-martial or administrative board (Jemionek et al. 2008). Following the implementation of this policy, reported illicit drug use among military personnel fell from 27.6 percent to 2.7 percent (Bray et al. 1995, 1999). By 2002, the Department of Defense was enforcing 100 percent annual (once-per-year) random drug testing for every member of the Armed Forces, including active-duty enlisted servicemembers, officers, Reservists, and National Guardsmen. Newly recruited servicemembers were given mandatory drug tests within 72 hours of entering active-duty (O'Connell 2003).

Common drug testing policies appear to have been somewhat ill-designed to handle the onset of the opioid crisis. While heroin was included on drug testing panels prior to 1999, prescription opioids were not included on drug testing panels until 2005, well after the onset of the opioid epidemic began. Oxycodone and oxymorphone were the first prescription opioids to be added to the drug test panel in 2005 (Platteborze et al. 2014). However, servicemembers with prescriptions were not subject to disciplinary action if drug testing reflected the prescribed dosage over the relevant time periods (Platteborze et al. 2014). Hydrocodone and hydromorphone were not added to the drug testing panel until 2012 (Rooney 2012), the year which also saw VA-issued opioid prescriptions beginning a steep decline.

3. Identification

To identify the causal impact of post-9/11 combat service on use and abuse of opioids, we exploit a natural experiment generated by the procedures through which active-duty U.S. Armed Forces personnel are assigned to overseas deployments. First, it is important to keep in mind that individual servicemembers are rarely deployed overseas. Rather, units (e.g., battalions) receive deployment orders. When servicemembers are assigned to their units, and those units are assigned by senior commanders (via Human Resources Command) to deployment duties, servicemen of equivalent military rank and occupation specialty are treated as perfect

[30] In addition to *United States v. Armstrong* (1980), another motivation for this policy change was a tragic aviation accident that occurred on May 26, 1981 aboard the USS Nimitz. After a missed approach to the aircraft carrier USS Nimitz, a fuel-critical Marine Corps EA-6B Prowler crashed on the flight deck, killing 14 crewmen, injuring 45 others, and destroying or damaging 19 other aircraft. The accident generated $416 million in real dollars in damages. Six postmortem autopsies revealed detectable levels of THC in those involved in the crash. Although it could not be proved that the drug use contributed to the accident, media outlets and intense congressional hearings focused on the drug scandal.

substitutes (Lyle 2006; Cesur et al. 2013; Cesur and Sabia 2016). As a rule, Human Resources Command cannot take the individual preferences, family situation, personality, or background characteristics of a servicemember into account when making deployment assignments (Lyle 2006; Engel et al. 2010). Senior commanders determine when, where (combat versus non-combat operations), and for how long to deploy units based on (i) the state of operational environment, which is dictated by world events, and (ii) the readiness and availability of suitable units, determined by equipment availability, timing of training completion, and the occupational composition of unit members (Army Regulation 220-1; Lyle 2006; Engel et al. 2010). These factors are outside of the control of any active-duty servicemember and are plausibly exogenous to subsequent opioid use and abuse of servicemembers.[31]

Thus, while an active-duty servicemember can affect the probability of a combat deployment by (i) choice of service branch, (ii) selection of military occupation, and (iii) re-enlistment decision (rank), *conditional* on branch, rank (service length), and military occupation, deployment assignments by Human Resources Command at any point in time are conditionally random.

The local average treatment effect (LATE) identified in this natural experiment is quite different from the draft lottery, which has been used in a number of prior studies that have examined the human capital and labor market effects of U.S. military service (Angrist 1993; Angrist and Chen 2011; Angrist et al. 2011; Card and Lemieux 2001, 2002). However, the LATE we identify captures an arguably more relevant policy parameter in the context of All-Volunteer Armed Forces (see Sabia and Skimmyhorn 2019 for a discussion).

The natural experiment described above has been exploited by scholars examining the impacts of military deployments on children's human capital acquisition (Lyle 2006; Engel et al. 2010), household violence (Cesur et al. 2016), veterans' binge drinking (Cesur et al. 2017), and veterans' labor market outcomes (Sabia and Skimmyhorn 2019).

4. Data

[31] Lyle (2006) and Sabia and Skimmyhorn (2019) document that "stay-back selection" – the hold back of approximately five percent of unit members at base as part of "stay-back" personnel – is an unimportant source of bias. Using administrative data and a two-stage least squares approach (2SLS) where battalion-level deployment orders are used as an instrument for individual deployment, these authors find that 2SLS and OLS estimates are statistically equivalent.

To estimate the impact of military deployments on opioid abuse, we draw data from two sources: the military module of the National Longitudinal Study of Adolescent and Adult Health (Add Health) and the Department of Defense Survey of Health and Related Behaviors Among Active Duty Personnel (HRB), each with advantages and disadvantages, discussed below. Our main analysis samples will include 482 male respondents from the Add Health and 11,542 men in the HRB. We also analyze the impact of combat exposure on the likelihood of prescription drug abuse among 3,198 servicewomen in the DOD data.

4.1 National Longitudinal Study of Adolescent and Adult Health (Add Health)

The Add Health is a nationally representative, school-based survey of middle and high school students in the United States, who were originally interviewed during the 1994-1995 school year (Wave I). Follow-up surveys were conducted in the subsequent academic year (the calendar year 1996) and five years later, when respondents were ages 18 to 26, Waves II and III respectively. The last wave of data (Wave IV) was collected in 2008. We draw data from the military module of the Wave IV survey, collected in 2007-2008.

Our analysis sample is comprised of 482 males ages 28 to 34 who reported active-duty military service, were deployed overseas during the period of the Iraq and Afghanistan wars, and provided non-missing information on (i) military characteristics, including military rank and occupation, branch of service, length and type of deployment (combat versus non-combat deployment), and (ii) prescription painkiller use and abuse.

We measure two opioid-related outcomes in the Add Health. First, using the Wave IV supplemental medication file, we measure whether the respondent has been prescribed a pain reliever by a physician.[32] We generate a dichotomous variable, *Prescription Painkiller,* set equal

[32] Respondents are told:

> "As you know, I want to record all prescription medications that you have used in the past four weeks. These medications include solid and nonsolid formulations that you may swallow, inhale, apply to the skin or hair, inject, implant, or place in the ears, eyes, nose, mouth, or any other part of the body. Have you taken any prescription medications in the last four weeks?"

If respondents answered the above in the affirmative, then the Add Health interviewer is given the following instruction:

> "If the interview is being conducted in the respondent's home or the medications are conveniently available (e.g., in a purse) ask the respondent to assemble the medications or their containers now so that you can

to 1 if the respondent has taken an analgesic prescription medication, comprised of narcotic analgesics, narcotic analgesic combinations, and miscellaneous analgesics, and set equal to 0 otherwise. We find that 9.3 percent of servicemen who had been deployed overseas used prescription pain reliever in the last month.[33]

Our measure of prescription painkiller abuse is generated using responses to the following survey item:

> *"[Have] you ever taken pain killers that were not prescribed for you, taken [them] in larger amounts than prescribed, more often than prescribed, for longer periods than prescribed, or that you took only for the feeling or experience they caused?*

We generate a dichotomous variable, *Painkiller Abuse,* set equal to 1 if the respondent reported non-medical use of pain killers. We find that 12.9 percent of respondents reported recreational use of prescription painkillers in their lifetime. Note that because this is an "ever" measure, we cannot know the precise timing of abuse relative to deployments. However, the longitudinal nature of the data will allow us to identify illicit substance use prior to enlistment.

In the Add Health, we measure deployment assignment among active-duty deployed servicemen using information about deployment histories. *Combat Zone Deployment* is set equal to 1 if the respondent reports an overseas deployment to a combat zone and is set equal to 0 if the respondent reports overseas assignment is exclusive to a non-combat zone. Approximately three-quarters (75.5 percent) of our deployed sample reported assignment to a combat zone. Conditional on military rank, occupation, and length/timing of service, it is this variation among overseas deployed personnel that we exploit for identification.

In addition to combat assignment, we also measure combat exposure among those deployed to combat zones via an indicator for whether the respondent engages the enemy in firefight in a combat zone, *Combat Zone with Enemy Firefight.*[34] We find that 36.7 percent of respondents reported assignment to a combat zone where they engaged the enemy in firefight.

> record information about them. If the respondent is unable or unwilling to assemble them now, ask him/her to list them from memory."

When all medications are collected, they are therapeutically classified using the most updated version of Multum LexiconTM. We find that approximately 27 percent of the sample of previously deployed active-duty servicemen reported taking prescription medication in the last four weeks.

[33]In contrast, 17.4 percent consumed only prescription medication that was not classified as a prescription pain reliever.

[34] Respondents were asked: "During your combat deployment, how many times did you engage the enemy in a firefight?"

Moreover, among those deployed to a combat zone where enemy firefight occurred, we also are able to measure whether the serviceman was wounded in combat, *Combat Zone with War Wounding* (8.9 percent of our sample).

One of the important advantages of the Add Health data, discussed in Section 4 below, is the inclusion of a rich set of military observables, which allows us to exploit a fairly clean natural experiment. In fact, the Add Health include the set of observables available to Human Resources Command when making deployment assignments. However, there are a number of notable disadvantages to these data. These include (i) a relatively small analysis sample of less than 500 servicemen, which creates a relatively low-power research design, (ii) an imprecisely timed measure of prescription painkiller abuse (mitigated by the availability of panel data), and (iii) a sample of servicemembers (ages 28 to 34) that may not be generalizable to the broader post-9/11 veteran population.

In addition, the measure of abuse is self-reported and thus likely to be lower-bound estimates of actual opioid abuse use. However, as long as measurement error is unrelated to military deployment, estimated marginal effects relative to the mean of the dependent variable should be unbiased. Given some of these concerns, we turn to a second data source.

4.2 Department of Defense Health and Related Behaviors Survey (HRB)

The 2008 DoD Survey of Health and Related Behaviors (HRB) Among Active Duty Personnel is designed to be representative of all active-duty servicemembers in all branches and pay grades of the U.S. Armed Forces. Collected by RTI, these data include 28,546 active-duty military servicemembers between the ages 18 and 50. The HRB survey excluded individuals who were absent without official leave (AWOL), incarcerated at the time of data collection, or attending a service academy from the interview. Our analysis sample consists of 11,542 male active-duty members of the armed forces who were deployed overseas and provided non-missing information on prescription pain reliever use or abuse.

Respondents are first asked:

> *"Have you been prescribed medication to relieve pain or discomfort by a doctor or other health professional?"*

Medication to relieve pain is defined in the survey (to the respondent completing it) as including Oxycodone, OxyCotin, Percodan, Percocet, Tylox, Hydrocodone, Vicodin, Lortac, Codeine, Demerol, Fentanyl, Methadone, and Morphine. We find that 12.9 percent report prior-month (*Prior-Month Painkiller*) use of pain relievers.

In addition, respondents were explicitly asked about the abuse of prescription painkillers:

> *"When did you last use pain relievers for non-medical reasons?"*

We find that 8.9 percent of respondents report the use of pain relievers for non-medical reasons in the last 30 days (*Prior-Month Painkiller Abuse*).

Finally, respondents are asked about their use of illicit narcotics, including heroin. We estimate that 0.6 percent report prior-month heroin use (*Prior-Month Heroin*).[35]

Concerning military deployments, we are unable to identify those deployed to combat zones that do not experience enemy firefight as in the Add Health. Our primary measure of combat assignment is, therefore, a measure of combat exposure, *Enemy Firefight*, generated using responses to the following survey item:

> *"Thinking about all of your deployments…how many times have you [or] members of [your] unit, received incoming fire from small arms, artillery, rockets, or mortars or fired on the enemy?"*

If the respondent reports that his unit has experienced enemy firefight, *Enemy Firefight* is set equal to 1, and is set equal to 0 otherwise.

Moreover, we create a dichotomous variable *War Wounding,* set equal to 1 if the respondent reported being "wounded in combat." We find that 5.2 percent of our deployed sample reported being injured in combat. To supplement this measure, we construct a binary variable *Restricted Physical Activity*, which reflects whether the serviceman suffered from pain or injury that limited his duty or physical activity for a week or longer in the prior year. Our estimates show that the prevalence of *Restricted Physical Activity* is about 10 percentage points higher (44 percent vs. 34 percent) among those who engaged the enemy in firefight during deployments relative to those that did not.

In addition to physical injuries, there is evidence that traumatic battlefield experience, particularly witnessing deaths on the battlefield or injuries/deaths among members of his unit may suffer from substantially increased risk of PTSD, a risk factor for opioid abuse. We construct a dichotomous variable, *Witness Death,* which measures whether the respondent "saw

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[35] In contrast to the Add Health data, heroin use is measured separately from cocaine and is also not restricted to injectable use.

dead bodies or human remains," and *Witness Ally Injury or Death* if the respondent "witnessed members of [his] unit or an ally unit being seriously wounded or killed." We find that 36.5 percent of deployed servicemen saw dead bodies or human remains, and 22.7 percent witnessed members of their units or allies seriously injured or killed. Finally, in our sample, we find that approximately 10 percent of active-duty deployed servicemembers screen positive for Post-Traumatic Stress Disorder.[36]

The HRB survey has a number of advantages over the Add Health, including a much larger sample size, which permits greater power and the exploration of heterogeneous treatment effects by the branch of service, rank (including enlisted versus officers), age, and gender. There are also detailed measures of combat exposure and more comprehensive measures of the mechanisms that could explain deployment effects on opioid abuse. However, an important limitation is the lack of detailed information on military occupation, an omission designed to protect the anonymity of the survey. This limitation could have an impact on our identification strategy. However, the HRB data do include some measures of skill attainment and Major Command, which have been shown to be very reasonable proxies for occupation in the context of the natural experiment we exploit (see Cesur and Sabia 2016). Borrowing from this approach, we use rank-by-branch-by-Major Command fixed effects to proxy for occupation, as well as control for detailed measures of educational attainment. In Section 4.4 below, we discuss descriptive empirical tests for the validity of our natural experiment.

4.3 Descriptive Statistics

Tables 1A and 1B provide descriptive statistics on prescription pain reliever use and abuse among the members of the armed forces, by their combat status. Table 1A shows findings for the Add Health. The results show that the use of prescription painkillers in the past four

[36] We generate an indicator of PTSD based on a PTSD Checklist-Civilian Version (PCL-C) test (Weathers et al. 1993). Individuals were asked 17 questions that captured symptoms of PTSD in which a score was calculated indicating whether they require further evaluation. Those who scored above 50 on this scale were coded as screening positive for PTSD. Questions asked whether participants had a loss of interest in activities that used to be enjoyable, being extremely alert or watchful, having physical reactions when reminded of a stressful experience, and feeling jumpy or easily startled. Respondents were asked to indicate how much they had been bothered by each of the 17 experiences in the last 30 days; response options were not at all, a little bit, moderately, quite a bit, and extremely. Each statement was scored from 1 to 5, and a sum for all items was computed. The standard diagnostic cutoff was used such that if the sum were greater than or equal to 50, participants were classified as needing further evaluation for current (past month) PTSD; those with a score less than 50 were considered not to require further evaluation.

weeks was modestly higher (1.8 percentage-points) among those deployed to combat zones versus non-combat zones. Rates of prior-month prescription painkiller use were substantially higher for those who engaged the enemy in firefight relative to those who were in combat zones without such firefight (12.4 vs. 7.5 percent). Moreover, rates of prescription painkiller abuse were higher among respondents who faced combat exposure relative to those who did not see such exposure.

Turning to the HRB Survey (Table 1B), we see a similar pattern of results. Means of prescription painkiller use and abuse were substantially higher among those who experienced enemy firefight in war relative to those who were not assigned to combat. Moreover, rates of prescription drug use were higher among those serving in branches of the military where combat is likely to be more intense (Army and Marines relative to Navy and Air Force). Finally, rates of illicit heroin use were substantially higher among those assigned to combat duties.

4.4 Empirical Methodology

First, to test the hypothesis that deployment assignments are unrelated to a wide set of personal and family background characteristics, conditional on military observables, we draw our Add Health sample and estimate the following equations:

$$\textit{Combat Zone Deployment}_i = \beta_0 + \beta_1\mathbf{X_i} + \beta_2\textit{Pre-Enlistment Drug Use}_i + \beta_3\mathbf{M_i} + \varepsilon_i \quad (1)$$

$$\textit{Combat Zone with Enemy Firefight}_i = \beta_0 + \beta_1\mathbf{X_i} + \beta_2\textit{Pre-Enlistment Drug Use}_i + \beta_3\mathbf{M_i} + \varepsilon_i \quad (2)$$

where $\mathbf{X_i}$ is a vector of pre-enlistment personal and family background characteristics for serviceman *i*, including age, height, weight, religion, gender, race/ethnicity, Peabody Picture Vocabulary Test (PPVT) score, parental household income, parental marital status, parental educational attainment, and number of siblings. While the Add Health dataset does not specifically include information on prescription painkiller abuse prior to enlistment, we are able to measure pre-enlistment abuse of other illicit substances. $\textit{Pre-Enlistment Drug Use}_i$ is set equal to 1 if servicemember *i* reported consuming marijuana, cocaine, inhalants, or other illegal drugs prior to enlistment and 0 otherwise. Finally, $\mathbf{M_i}$ is a vector of military observables including the branch of service, military rank, length and timing of service, and occupation.

If military procedures conditionally randomly assign active-duty servicemembers to combat deployments, then estimates of β_1 and β_2 should be statistically indistinguishable from zero. Our results in Table 2 are consistent with this hypothesis. Conditional on military observables, we find little evidence that background characteristics are individually or jointly significant predictors of the probability of being deployed to a combat versus non-combat zone (column 1) or to a combat zone with enemy firefight relative to an overseas combat deployment without such firefight (column 2) or to a non-combat zone deployment (column 3). This includes pre-enlistment illicit substance use. Of 81 coefficient estimates, only one is statistically significant at conventional levels.[37]

Turning to our central analysis, we estimate the relationship between post-9/11 combat deployments and opioid consumption via the following least squares regression:

$$Opioid_{\text{i}} = \alpha_0 + \alpha_1 Combat\ Zone\ Deployment_i + \alpha_2 \mathbf{M_i} + \mu_{\text{i}} \quad (3a)$$

$$Opioid_{\text{i}} = \alpha_0 + \alpha_1 Combat\ Zone\ Deployment_i + \alpha_2 \mathbf{M_i} + \alpha_3 \mathbf{X_i} + \beta_2 Pre\text{-}Enlistment\ Drug\ Use_{\text{it-1}} + \mu_{\text{i}} \quad (3b)$$

where $Opioid_i$ measures respondent *i*'s opioid use or abuse. In alternate specifications, *Combat Zone Deployment* is disaggregated to include those deployed to combat zones where enemy firefight emerges (*Combat Zone with Enemy Firefight*) and combat zones without enemy firefight (*Combat Zone without Enemy Firefight*). If, as argued above, deployment assignment is exogenous to prescription painkiller use and abuse, then estimates of α_1 in equations (3a) and (3b) should be largely unchanged.

Turning to the HRB Survey, we estimate the following equation via least squares:

$$Opioid_{\text{i}} = \delta_0 + \delta_1 Enemy\ Firefight_{\,i} + \delta_2 \mathbf{M_i} + \delta_3 \mathbf{X_i} + \nu_{\text{i}} \quad (4)$$

where $\mathbf{M_i}$ includes controls for branch of service, military rank, timing of service, and installation-level Major Command (including interactive effects) and $\mathbf{X_i}$ includes controls for age, race/ethnicity, and marital status. An important drawback of the HRB Survey is the lack of information on military occupation, owed to concerns about DoD ensuring that surveys were

[37] In column (2), Hispanic ethnic identification negatively related to combat assignment (column 2). This control is included in all regressions and restricting the sample to non-Hispanics produces a very similar pattern of results.

anonymous. However, recent work by Cesur and Sabia (2016) show compelling evidence that detailed rank and branch-by-major command controls in the HRB Survey sufficiently proxy for occupation such that the natural experiment we exploit remains valid. In addition, in Appendix Table 1, we show that if we restrict our set of observables in the Add Health to the observables available in the HRB survey, our estimates of α_1 are quantitatively similar. We detect no evidence that estimated combat effects are upwardly biased. This lends some support to the hypothesis that estimates of δ_1 should be unbiased. Moreover, the DoD data do not allow us to distinguish between deployments to combat zones with and without enemy firefight. Therefore, if deployments to combat zones where enemy firefight does not materialize causes opioid abuse, perhaps because of (i) adverse psychological effects of the risk of violence, or (ii) access to low-cost domestic sources of opioids, then estimates from equation (2) will be lower-bound estimates of the effect of combat.

5. Results

Our main results are shown in Tables 3 through 10 below. All models are estimated via OLS and standard errors corrected for heteroscedasticity are shown in parentheses.

5.1 Add Health Survey Results

First, using data from the Add Health (Table 3), we find that an overseas deployment assignment to a combat zone (relative to an overseas deployment to a non-combat zone) is associated with a 3 to 5 percentage-point increase in the probability of past month prescription painkiller use (column 1, Panels I-III). While these effects are not statistically distinguishable from zero at conventional levels, when we disaggregate combat zone deployments by whether combat exposure materialized (column 1, Panel IV), we find that combat exposure is associated with a 7 percentage-point increase in prescription painkiller abuse (Panel IV). These effects are largely driven by those who were wounded in combat (Panel V). This pattern of findings is consistent with the hypothesis that opioid prescriptions were commonly issued to veterans who suffered war injuries.[38]

[38] In unreported specifications, we also performed our balancing tests for wounding in combat. These exercises produce qualitatively similar estimates to those presented in Table 2. In particular, out of 54 coefficients, only three were statistically distinguishable from zero at conventional levels.

Turning to prescription opioid abuse (column 2), we find that combat assignment is associated with a 7 percentage-point increase in non-medical use of prescription painkillers (Panel I). Controlling for individual and family characteristics (Panel II) and pre-enlistment drug use (Panel III) has little effect on the magnitude of the combat effect, suggesting that combat assignment (conditional on rank and occupation) is plausibly exogenous to background characteristics of servicemen.

In contrast to prescription use, we find that the probability of opioid abuse rises for those assigned to combat zones whether or not enemy firefight materializes (column 2, Panel IV) and independent of whether the veteran suffered a combat injury (column 2, Panel V). These findings suggest that addiction may not occur only via one's own physical injuries, but also through psychological, peer-related, or low-cost supply channels.

5.2 HRB Survey Results

Our estimates from the HRB survey are generally consistent with those obtained using the Add Health. Our findings in Table 4A show that assignment to a combat zone with enemy firefight is associated with a 2.7 percentage-point increase in prescription painkiller use (column 1, Panel I), and a 3.1 percentage point-increase in prescription painkiller abuse (column 2, Panel I). Moreover, if, as the Add Health results in Panel III of Table 3 suggest, combat zone assignment without exposure increases opioid use disorders, estimated abuse effects in the HRB survey may be lower bound estimates of the impact of post-9/11 combat assignment on opioid abuse.[39]

In addition to causing prescription painkiller abuse, our results also show that post-9/11 combat assignments induce some veterans to turn to the illicit heroin market (column 3). We find that combat exposure is associated with a 1.4 percentage-point increase in prior month illicit heroin use, a large effect relative to a small sample mean.

Branch-specific findings in the remaining panels of Table 4A suggest the largest abuse effects of combat assignment for those serving in the Army (Panel II), Marines (Panel III), and Navy (Panel IV) relative to the Air Force (Panel V). This finding is consistent with smaller

[39] This is because those deployed to combat zones without enemy firefight and those deployed to non-combat zones are pooled as the comparison group given data limitations in the HRB survey.

adverse physical and mental health effects of combat exposure for airmen due to lessened proximity to deaths and injuries or heterogeneous treatment effects across servicemembers who select into different service branches (Cesur et al. 2013).

In Table 4B, we explore the intensive margin of prescription painkiller abuse. Respondents are asked whether their prescription painkiller abuse has increased since the time of enlistment. We estimate the impact of combat exposure on the probability of painkiller abuse increasing since enlistment both unconditionally (column 1) and conditional on ever experiencing abuse (column 2). The findings are consistent with the hypothesis that combat exposure may increase the frequency or intensity with which those abusing prescription opioids do so.

To what extent does legitimate opioid use co-occur with prescription painkiller or heroin abuse? In Table 5, we find that combat exposure increases the likelihood of prescription painkiller use without abuse by 1.1 percentage points (column 1), which suggests that at least some combat-induced opioid use is limited to its intended medical use. Moreover, we find that combat exposure increases the probability of legitimate use and abuse of painkillers (column 2) by a similar magnitude as abuse without a prescription (column 3). A similar pattern exists for heroin use (columns 4 and 5). Together, these results suggest that while a veteran's own prescriptions may be a source of abuse, alternate sources are probably also important.[40]

5.3 Heterogeneous Effects of Combat on Opioid Abuse

Next, we examine whether the effects of combat on opioid abuse differ by age, gender, and enlisted personnel as compared to officers. Our results in Table 6 show that the effect of combat assignment on opioid abuse is largest for younger servicemen ages 18-to-24 years old (Panel I) relative to those ages 25 and older (Panels II and III). This pattern of results is consistent with prior evidence that the mental health and substance use effects of war are more substantial for younger combat veterans (Cesur et al. 2016). This may be because older individuals are often of higher rank and have re-enlisted, reflecting greater resilience, better health, or particular personality traits that reduce the opioid abuse effects of combat.

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[40] In Appendix Table 2, we estimate the impact of combat exposure on prescription painkiller abuse (columns 1 and 2) and heroin use (columns 3 and 4), conditional on receipt of an opioid prescription and non-receipt. The results are similar to those presented in Table 5.

Male servicemen comprise 78 percent of the total active-duty deployed sample in the HRB survey. This is, in part, because prior to January 2013, the Department of Defense policy banned women from many front-line combat positions via the Combat Exclusion Policy. Still, females' assignments during the pre-2013 period still brought them in contact with combat injuries and deaths, even as part of support operations. Moreover, the prevalence of insurgency warfare was quite high during the Operations Enduring Freedom and Iraqi Freedom in comparison to prior conflicts. Thus, female servicemembers faced much greater combat exposure in the post-9/11 era than in prior conflicts (Street et al. 2009).[41] When we examine the impact of combat assignment on opioid abuse among females (Panel IV), we find some evidence that combat assignment is associated with increases in opioid abuse.

Prior military research finds that military deployments have larger adverse effects on the health and wellbeing of enlisted servicemembers and their families as compared to officers (Cesur and Sabia 2016; Lyle 2006). Our findings in Panels V and VI are largely consistent with this result. This finding may reflect that those who become officers have particular cognitive or non-cognitive skills, support networks, or financial resources that effectively mitigate the adverse psychological effects of combat.

5.4 Mechanisms

The above results provide consistent evidence that combat assignments increase the risk of opioid abuse. In Table 7, we explore specific combat experiences that might be driving this result. We find the effects of combat exposure on opioid use and abuse are largest, by a large margin, among servicemen wounded in battle (Panel I). This result suggests that legitimate treatment for war injuries is a likely pathway to addiction. However, there is some residual opioid use and abuse effect of combat for those not wounded (see Appendix Table 4), suggesting that there may be other pathways to addiction than treatment for combat injury. In Panels II and III of Table 7, we show that traumatic battlefield experiences — such as witnessing deaths, particularly those of unit members or allies — increase opioid abuse, consistent with the hypothesis that a psychological channel may be important as well.

[41] As Appendix Table 3 shows, 38 percent of deployed women were assigned to combat zones with enemy firefight. In addition, 22 percent of women witnessed deaths and injuries, and 2 percent were injured themselves in combat.

To explore the relative importance of peers or exposure to supply-side channels, in Table 8, we isolate the impact of combat exposure from deployment frequency and usual deployment length.[42] If unit-level peer effects or supply side channels are important, we might expect longer deployment lengths to be more important than combat exposure. Our results suggest that combat exposure rather than deployment duration is more important.

In Table 9, we take another tack to explore the relative importance of various channels. In Panel I, we reproduce estimates of equation (4) (from Panel I of Table 4) and in subsequent panels add controls for observable mechanisms through which combat exposure may affect opioid use: being wounded in battle, being restricted from duty due to pain or injury, positive screening for PTSD, and observing casualties or injuries in war.[43]

The results suggest that about one-third of the effect of combat exposure on opioid abuse can be explained by war injuries. A higher percentage of the heroin effect (close to 58 percent) can be explained by war injuries. We observe a similar pattern in Panel III when we investigate the potential role of physical mobility restrictions.

Psychological channels related to PTSD (Panel IV) and battlefield trauma (Panel V) also appear to be powerful mediators. In particular, witnessing war casualties can explain one-half to two-thirds of the combat exposure effect we observe. Together (Panel VI), the psychological and physical health-related mechanisms can explain at least 75 percent of the effect of combat exposure on opioid use and abuse that we observe in the HRB survey.

Finally, prior medical research suggests that the risk of opioid abuse may be exacerbated by PTSD (Peck et al. 2018). We empirically confirm this suggestion in Appendix Table 6, where we show that PTSD substantially increases the adverse effects of combat.

5.4 Joint Opioid and Other Prescription Abuse

The combined use of opioids with other Central Nervous System (CNS) depressants, such as benzodiazepines, barbiturates, sedatives, and tranquilizers can exacerbate the potential detrimental effects of opioid abuse (Cone et al. 2004; Salzman 1991). During the period

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[42]To complete this exercise, we use the information available in the HRB survey on the number of post-September 11 deployments and the length of combat deployments in the prior 12 months. In the HRB data, combat vs. non-combat deployment status is only available for the past 12 months.

[43] Not surprisingly, we find that each of these outcomes is significantly positively associated with engaging the enemy in firefight (Appendix Table 5).

corresponding to the national opioid crisis, the rate of simultaneous opioid and benzodiazepines prescriptions increased significantly (Hwang et al. 2016) as did the prevalence of emergency department visits for nonmedical joint use (Jones and McAninch 2015).

The joint use of these prescription medications was also commonplace among the members of the Armed Forces, with up to 27 percent of veterans who were prescribed opioids also being prescribed benzodiazepines (Park et al. 2015). Roughly half of drug overdose deaths occurred when veterans were jointly prescribed these medications (Park et al. 2015).[44]

In Table 10, we explore whether combat-induced prescription drug abuse extends to sedatives and tranquilizers.[45] In the first three columns, we find that combat exposure increases the use and abuse of sedatives and tranquilizers (column 3). Exposure also increases the joint non-medical use of sedatives (column 4) and tranquilizers (column 5) with prescription painkillers, which may be an especially deadly combination for veterans.

6. Conclusions

U.S. war veterans are at the forefront of the U.S. opioid epidemic. This study is the first to estimate the impact of post-9/11 military deployments on opioid abuse. Using two national datasets and exploiting a natural experiment in overseas deployment assignment, we find that combat assignment significantly increases consumption of prescription narcotics both for medical and non-medical purposes. We also uncover evidence that combat exposure increases heroin use. Estimated combat effects are largest for younger, enlisted active-duty servicemen.

We find that while treatment for war injuries is one channel through which combat deployments increase opioid abuse, there are critical psychological channels at work as well, including PTSD and the mental health effects of exposure to battlefield trauma. In addition, we find that post-9/11 combat assignments are associated with a substantial increase in the utilization of sedatives and tranquilizers for non-medical purposes. Moreover, we find that facing the theatre of war increases the likelihood of concomitant abuse of opioids with other CNS depressing drugs, such as benzodiazepines. This result is particularly worrisome given that the

[44] In response to this public health problem, the Food and Drug Administration (FDA) issued a 2016 directive that the concomitant use of opioid medicines with benzodiazepines requires its strongest warning (FDA 2016). https://www.fda.gov/Drugs/DrugSafety/ucm518473.htm

[45] Examples of prescription sedatives include in the HRB Survey are Ambien, Lunesta, and Dalmane; examples of prescription tranquilizers include Ativan or Lorapazem, Klonopin or Clonazepam, Vistaril, and Flexeril.

risk of overdose from these drugs, taken in combination with opioids, exacerbates the risk of death. Together, our findings point to combating opioid abuse as an important front in the Global War on Terrorism.

The U.S. Department of Defense, aware of concerns about opioid addiction and overdose, has undertaken a number of strategies to try to combat the problem, including (i) promotion of non-pharmacological strategies for pain management such as yoga, acupuncture, sports, and physical therapy, (ii) more holistic training in behavioral health for employees at Military Treatment Facilities, (iii) increased availability of naloxone, an opioid antagonist, on military installations, (iv) expanded education and communication programs, (v) more complete and aggressive random drug testing, and (vi) increasing monitoring of opioid prescriptions via the 2017 Veterans Prescription Data Accountability Act[46] (U.S. Department of Defense 2017).

Since 2012, the rate of opioid prescribing by the VA has fallen by over 40 percent (U.S. Department of Veteran Affairs 2018). This has been achieved, in part, by raising the costs for prescriptions to patients by increasing the number of VA physician visits per refill as well as the greater reluctance of VA physicians to recommend opioids to treat chronic pain. However, some policymakers wonder whether dramatic cuts in opioid prescriptions by VA providers have happened without well-targeted alternative effective chronic pain management strategies. Substitution into the illicit heroin market and the psychological consequences of withdrawal remain a concern.[47]

One relatively recent strategy to treat chronic pain without the use of narcotics is through the use of medical marijuana. There is growing evidence that state medical marijuana laws are

[46] The Veteran Affairs Prescription Data Accountability Act requires VA employees and VA-authorized prescribers to report controlled substance prescriptions for both veterans and non-veterans to the PDMP in the state where they practice. In January 2018, the Department of Defense released VA opioid prescribing data to the public at the following website: https://www.data.va.gov/story/department-veterans-affairs-opioid-prescribing-data

[47] A 2017 *Newsweek* article describing this dilemma captured the sense of crisis and pressure military policymakers are facing. See "How the VA Fueled the National Opioid Crisis and Is Killing Thousands of Veterans" at http://www.newsweek.com/2017/10/20/va-fueled-opioid-crisis-killing-veterans-681552.html. See also:

> "[Veterans] eased the chronic pain with the help of narcotics prescribed for years by the…Veterans Medical Center. Then the VA made a stark and sudden shift: Instead of doling out pills to thousands of veteran…— a policy facing mounting criticism — they began cutting dosages or canceling prescriptions, and, instead, began referring many vets to alternative therapies such as acupuncture and yoga. At first, the change seemed to work: Worrisome signs of prescription drug addiction among a generation of vets appeared to ebb. But the well-intentioned change in prescription policy has come with a heavy cost. Vets cut off from their meds say they feel abandoned, left to endure crippling pain on their own, or to seek other sources of relief. Or worse." (Star Tribune 2017)

associated with a reduction in prescription pain medication fills (Bradford and Bradford 2016, 2017; Bradford et al. 2018), opioid-related hospitalization stays (Shi 2017), and overall age-adjusted opioid death rates (Bachhuber et al. 2014). Reductions in painkiller-related addiction and mortality appear to be driven mainly by medical marijuana laws that are accompanied by dispensaries (Powell et al. 2018). While marijuana legalization is certainly not a silver bullet, evidence that marijuana and opioids are substitutes suggests that access to medical marijuana may provide an alternative, less addictive, and less unhealthy means of treating pain. However, a January 2018 memo by Former Attorney General Jeff Sessions rescinded the Obama-era policy of not interfering with state marijuana laws, pledging to support Federal law treating marijuana as a Schedule I drug. While the VA has vowed to continue protecting doctor-patient communications about medical marijuana use, critics worry that the Sessions memo will have the unintended consequence of increasing illicit use of opioids among veterans.

7. References

Adams, Rachel Sayko, Cindy Parks Thomas, Grant A. Ritter, Sue Lee, Mayada Saadoun, Thomas V. Williams, and Mary Jo Larson. 2018. "Predictors of Postdeployment Prescription Opioid Receipt and Long-Term Prescription Opioid Utilization Among Army Active Duty Soldiers", *Military Medicine 184*(1-2): 101-109.

Ahmed, Azam. 2016. "Drug That Killed Prince Is Making Mexican Cartels Richer, US Says," *New York Times*. Available at: https://www.nytimes.com/2016/06/10/world/americas/drug-that-killed-prince-is-making-mexican-cartels-richer-us-says.html

Alpert, Abby, David Powell, and Rosalie Liccardo Pacula. 2018. "Supply-Side Drug Policy in the Presence of Substitutes: Evidence From the Introduction of Abuse-Deterrent Opioids," *American Economic Journal: Economic Policy 10*(4): 1-35.

American Association of Family Physicians (AAFP). 2016. Available at: https://www.aafp.org/dam/AAFP/documents/advocacy/prevention/risk/LT-VA-PDMPs-050516.pdf

Angrist, Joshua D. 1993. "The Effect of Veterans Benefits on Education and Earnings," *Industrial and Labor Relations Review 46*(4): 637-652.

Angrist, Joshua D., and Stacey H. Chen. 2011. "Schooling and the Vietnam-Era GI Bill: Evidence from the Draft Lottery," *American Economic Journal: Applied Economics 3*(2): 96-118.

Angrist, Joshua D., Stacey H. Chen, and Jae Song. 2011. "Long-Term Consequences of Vietnam-Era Conscription: New Estimates Using Social Security Data," *American Economic Review*: *101*(3): 334-38.

Army Regulation 220-1. 2010. Amy Unit Status Reporting and Force Registration – Consolidated Policies.

Aurin, Marcus. 2000. "Chasing the Dragon: The Cultural Metamorphosis of Opium in the United States, 1825-1935," *Medical Anthropology Quarterly 14*(3): 414-441.

Axelrod, Jim. 2013. "Veterans Dying from Overmedication," *CBS News*. Available at: https://www.cbsnews.com/news/veterans-dying-from-overmedication/

Bachhuber, Marcus A., Brendan Saloner, Chinazo O. Cunningham, and Colleen L. Barry. 2014. "Medical Cannabis Laws and Opioid Analgesic Overdose Mortality in the United States, 1999-2010," *Journal of the American Medical Association: Internal Medicine 174*(10): 1668-1673.

Baser, Onur, Lin Xie, Jack Mardekian, David Schaaf, Li Wang, and Ashish V. Joshi. 2014. "Prevalence of Diagnosed Opioid Abuse and its Economic Burden in the Veterans Health Administration," *Pain Practice 14*(5): 437-445.

Becker, William C., David A. Fiellin, Rollin M. Gallagher, Kelly S. Barth, Jennifer T. Ross, and David W. Oslin. 2009. "The Association Between Chronic Pain and Prescription Drug Abuse in Veterans," *Pain Medicine 10*(3): 531-536.

Birk, Erica, and Glen R. Waddell. 2017. "The Mitigating Role of Prescription Drug Monitoring Programs in the Abuse of Prescription Drugs," Working Paper No. 10990, Institute for the Study of Labor (IZA).

Bohnert, Amy SB, Mark A. Ilgen, Sandro Galea, John F. McCarthy, and Frederic C. Blow. 2011. "Accidental Poisoning Mortality Among Patients in the Department of Veterans Affairs Health System," *Medical Care* 393-396.

Booth, Martin. 1996. "Opium: A History," New York: St. Martin's Press.

Bradford, Ashley C., and W. David Bradford. 2016. "Medical Marijuana Laws Reduce Prescription Medication Use in Medicare Part D," *Health Affairs 35*(7): 1230-1236.

Bradford, Ashley C., and W. David Bradford. 2017. "Medical Marijuana Laws May be Associated With a Decline in the Number of Prescriptions for Medicaid Enrollees," *Health Affairs 36*(5): 945-951.

Bradford, Ashley C., W. David Bradford, Amanda Abraham, and Grace Bagwell Adams. 2018. "Association between US state medical cannabis laws and opioid prescribing in the Medicare Part D population." *JAMA Internal Medicine* 178(5): 667-672.

Brady, Kathleen T., Peter Tuerk, Sudie E. Back, Michael E. Saladin, Angela E. Waldrop, and Hugh Myrick. 2009. "Combat Posttraumatic Stress Disorder, Substance Use Disorders, and Traumatic Brain Injury," *Journal of Addiction Medicine 3*(4): 179.

Bray, Robert M., Larry A. Kroutil, and S.C. Wheeless. 1995. "Department of Defense Survey of Health Related Behaviors Among Military Personnel, Report No. RTI/6019/06-FR," Research Triangle Institute, Research Triangle Park, NC.

Bray, Robert M., John A. Fairbank, and Mary Ellen Marsden. 1999. "Stress and Substance Use Among Military Women and Men," *The American Journal of Drug and Alcohol Abuse 25*(2): 239-256.

Brushwood, David B. 2003. "Maximizing the Value of Electronic Prescription Monitoring Programs," *The Journal of Law, Medicine & Ethics 31*(1): 41-54.

Buchmueller, Thomas C., and Colleen Carey. 2018. "The Effect of Prescription Drug Monitoring Programs on Opioid Utilization in Medicare," *American Economic Journal: Economic Policy 10*(1): 77-112.

Card, David, and Thomas Lemieux. 2001. "Going to College to Avoid the Draft: The Unintended Legacy of the Vietnam War," *American Economic Review 91*(2): 97-102.

Card, David, and Thomas Lemieux. 2002. "Did Draft Avoidance Raise College Attendance During the Vietnam War?" Working Paper No. 46, Center for Labor Economics, University of California, Berkeley.

Cesur, Resul, Joseph J. Sabia, and Erdal Tekin. 2013. "The Psychological Costs of War: Military Combat and Mental Health," *Journal of Health Economics 32*(1): 51-65.

Cesur, Resul, and Joseph J. Sabia. 2016. "When War Comes Home: The Effect of Combat Service on Domestic Violence," *Review of Economics and Statistics 98*(2): 209-225.

Cesur, Resul, Alexander Chesney, and Joseph J. Sabia. 2016. "Combat Exposure, Cigarette Consumption, and Substance Use," *Economic Inquiry 54*(3): 1705-1726.

Clancy, Dr. Carolyn, M.D. 2015. "VA Opioid Prescription Policy, Practice and Procedures: Hearings before the Committee on Veterans' Affairs, Senate, 114th Cong. 1"

Coombs, Robert H., and Louis Jolyon Wes, eds. 1991. "Drug Testing: Issues and Options," New York: Oxford University Press.

Cockburn, Patrick. 2007. "Opium: Iraq's Deadly New Export," Independent, 23 May.

Compton, Wilson M., and Nora D. Volkow. 2006. "Major Increases in Opioid Analgesic Abuse in the United States: Concerns and Strategies," *Drug and Alcohol Dependence 81*(2): 103-107.

Compton, Wilson M., Christopher M. Jones, and Grant T. Baldwin. 2016. "Relationship Between Nonmedical Prescription-Opioid Use and Heroin Use," *New England Journal of Medicine 374*(2): 154-163.

Cone, Edward J., Reginald V. Fant, Jeffrey M. Rohay, Yale H. Caplan, Mayra Ballina, Robert F. Reder, and J. David Haddox. 2004. "Oxycodone Involvement in Drug Abuse Deaths. II. Evidence for Toxic Multiple Drug-Drug Interactions," *Journal of Analytical Toxicology 28*(7): 616-624.

Congressional Research Service. 2018. "American War and Military Operations Casualties: Lists and Statistics." Available at: https://fas.org/sgp/crs/natsec/RL32492.pdf

Centers for Disease Control and Prevention. 2017. "Drug Overdose Deaths in the United States, 1999–2016," *NCHS Data Brief* No. 294 Available at: https://www.cdc.gov/nchs/data/databriefs/db294.pdf

Council on Foreign Relations. 2010. "The Good and Bad News About Afghan Opium." Available at: https://www.cfr.org/expert-brief/good-and-bad-news-about-afghan-opium

Dowell, Deborah, Kun Zhang, Rita K. Noonan, and Jason M. Hockenberry. 2016. "Mandatory Provider Review and Pain Clinic Laws Reduce the Amounts of Opioids Prescribed and Overdose Death Rates," *Health Affairs*, *35*(10): 1876-1883.

Dupont, R. and Amos, D. 2001. American Public Radio [Radio Series]. St. Paul: American Public Media Group.

Edlund, Mark J., Bradley C. Martin, Joan E. Russo, Andrea DeVries, Jennifer Brennan Braden, and Mark D. Sullivan. 2014. "The Role of Opioid Prescription in Incident Opioid Abuse and Dependence Among Individuals With Chronic Noncancer Pain: the Role of Opioid Prescription," *The Clinical Journal of Pain 30*(7): 557–564.

Engel, Rozlyn C., Luke B. Gallagher, and David S. Lyle. 2010. "Military Deployments and Children's Academic Achievement: Evidence from Department of Defense Education Activity Schools," *Economics of Education Review 29*(1): 73-82.

Evans, William N., Ethan MJ Lieber, and Patrick Power. 2018. "How the Reformulation of OxyContin Ignited the Heroin Epidemic," Working Paper No. w24475, National Bureau of Economic Research.

Fishman, Scott M., Jennifer S. Papazian, Susana Gonzalez, Paul S. Riches, and Aaron Gilson. 2004. "Regulating Opioid Prescribing Through Prescription Monitoring Programs: Balancing Drug Diversion and Treatment of Pain," *Pain Medicine 5*(3): 309-324.

Gellad, Walid F., Florentina E. Sileanu, Jennifer A. Hale, Thomas R. Radomski, Adam J. Gordon, Chester B. Good, and Michael J. Fine. 2018. "Impact of Dual Use of Department of Veterans Affairs and Medicare Part D Drug Benefits on Potentially Unsafe Opioid Use," *American Journal of Public Health 108*(2): 248-255.

General Accounting Office. 2018. "VA HEALTH CARE: Progress Made Towards Improving Opioid Safety, but Further Efforts to Assess Progress and Reduce Risk Are Needed." Available at: https://www.gao.gov/assets/700/692061.pdf

Gupta, Dr. Sanjay, M.D. 2015. "Vietnam, Heroin and the Lesson of Disrupting Addiction," *CNN*, December 23. Available at: https://www.cnn.com/2015/12/21/health/vietnam-heroin-disrupting-addiction/index.html.

Grecu, Anca M., Dhaval M. Dave, and Henry Saffer. 2019. "Mandatory Access Prescription Drug Monitoring Programs and Prescription Drug Abuse," *Journal of Policy Analysis and Management 38*(1): 181-209.

Hedegaard, Holly, Margaret Warner, and Arialdi M. Miniño. 2017. "Drug Overdose Deaths in the United States, 1999-2015," *NCHS Data Brief 273:* 1-8.

Hwang, Catherine S., Elizabeth M. Kang, Cynthia J. Kornegay, Judy A. Staffa, Christopher M. Jones, and Jana K. McAninch. 2016. "Trends in the Concomitant Prescribing of Opioids and Benzodiazepines, 2002− 2014," *American Journal of Preventive Medicine 51*(2): 51-160.

Institute of Medicine of The National Academies. 2011. "Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research." Available at: https://iprcc.nih.gov/sites/default/files/IOM_Pain_Report_508C.pdf

Irving, J. 1988. "Drug Testing in the Military--Technical and Legal Problems," *Clinical Chemistry 34*(3): 637-640.

Islam, M. Mofizul, and Ian S. McRae. 2014. "An Inevitable Wave of Prescription Drug Monitoring Programs in the Context of Prescription Opioids: Pros, Cons and Tensions," *BMC Pharmacology and Toxicology 15*(1): 46.

Jemionek, John F., Curtis L. Copley, Michael L. Smith, and Marilyn R. Past. 2008. "Concentration Distribution of the Marijuana Metabolite Δ9-Tetrahydrocannabinol-9-Carboxylic Acid and the Cocaine Metabolite Benzoylecgonine in the Department of Defense Urine Drug-Testing Program," *Journal of Analytical Toxicology 32*(6): 408-416.

Johannes, Catherine B., T. Kim Le, Xiaolei Zhou, Joseph A. Johnston, and Robert H. Dworkin. 2010. "The Prevalence of Chronic Pain in United States Adults: Results of an Internet-Based Survey," *Journal of Pain 11*(11): 230-1239.

Jones, Mark R., Omar Viswanath, Jacquelin Peck, Alan D. Kaye, Jatinder S. Gill, and Thomas T. Simopoulos. 2018. "A Brief History of the Opioid Epidemic and Strategies for Pain Medicine," *Pain and Therapy 7*: 13-21.

Jones, Christopher M., and Jana K. McAninch. 2015. "Emergency Department Visits and Overdose Deaths from Combined Use of Opioids and Benzodiazepines," *American Journal of Preventive Medicine 49*(4): 493-501.

Kan, Paul R. 2008. "Drug Intoxicated Irregular Fighters: Complications, Dangers, and Responses," Army War College Strategic Studies Institute, Carlisle Barracks, PA.

Katz, Josh. 2017. "The First Count of Fentanyl Deaths in 2016: Up 540% in Three Years," *The New York Times*. Available at: https://www.nytimes.com/interactive/2017/09/02/upshot/fentanyl-drug-overdose-deaths.html?action=click&module=RelatedCoverage&pgtype=Article&region=Footer

Korsmeyer, Pamela, and Henry R. Kranzler. 2009. "Encyclopedia of Drugs, Alcohol & Addictive Behavior," USA: Macmillan Reference.

Lin, Lewei Allison, Talya Peltzman, John F. McCarthy, Elizabeth M. Oliva, Jodie A. Trafton, and Amy SB Bohnert. 2019. "Changing Trends in Opioid Overdose Deaths and Prescription Opioid Receipt Among Veterans." *American Journal of Preventive Medicine* 57 (1): 106-110.

Lyle, David S. 2006. "Using Military Deployments and Job Assignments to Estimate the Effect of Parental Absences and Household Relocations on Children's Academic Achievement," *Journal of Labor Economics 24*(2): 319-350.

Massing, Michael. 1998. "The Fix," New York: Simon & Schuster.

McCain, John. 2017. "Senator John McCain Reintroduces Legislation to Prevent Overmedication and Combat Suicide Among Veterans." Available at: https://www.mccain.senate.gov/public/index.cfm/2017/3/senator-john-mccain-reintroduces-legislation-to-prevent-overmedication-combat-suicide-among-veterans

McFall, Miles E., Priscilla W. Mackay, and Dennis M. Donovan. 1992. "Combat-Related Posttraumatic Stress Disorder and Severity of Substance Abuse in Vietnam Veterans," *Journal of Studies on Alcohol 53*(4): 357-363.

McKenna, Cailin R. 2007. "Trends in Substance Abuse Research," Nova Publishers.

Meier, Andrea, Chantal Lambert-Harris, Mark P. McGovern, Haiyi Xie, Melissa An, and Bethany McLeman. 2014. "Co-Occurring Prescription Opioid Use Problems and Posttraumatic Stress Disorder Symptom Severity," *American Journal of Drug and Alcohol Abuse 40*(4): 304-311.

Merboth, Marcia K., and Susan Barnason. 2000. "Managing Pain: the Fifth Vital Sign," *The Nursing Clinics of North America 35*(2): 375-383.

Miller, Matthew, Catherine W. Barber, Sarah Leatherman, Jennifer Fonda, John A. Hermos, Kelly Cho, and David R. Gagnon. 2015. "Prescription Opioid Duration of Action and the Risk of Unintentional Overdose Among Patients Receiving Opioid Therapy," *Journal of the American Medical Association: Internal Medicine 175*(4): 608-615.

Mosher, H. J., E. E. Krebs, M. Carrel, P. J. Kaboli, M. W. Vander Weg, and B. C. Lund. 2015. "Trends in Prevalent and Incident Opioid Receipt: An Observational Study in Veterans Health Administration, 2004–2012," *Journal of General Internal Medicine 30*(5): 597-604.

Mularski, Richard A., Foy White-Chu, Devorah Overbay, Lois Miller, Steven M. Asch, and Linda Ganzini. 2006. "Measuring Pain as the 5th Vital Sign Does Not Improve Quality of Pain Management," *Journal of General Internal Medicine 21*(6): 607-612.

Murphy, Francis X. Forthcoming. "Social Influences on Human Capital Investment: Evidence from a Continuing Education Program in the US Army," *Journal of Labor Economics.*

National Academies of Sciences, Engineering, and Medicine. Phillips JK, Ford MA, Bonnie RJ, editors. 2017. *Pain Management and the Opioid Epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use*. (Washington DC: National Academies Press; 2017). Available at: https://www.ncbi.nlm.nih.gov/books/NBK458662/

National Center for Complementary and Integrative Health. 2015. "Report of the Working Group on Strengthening Collaborations with the U.S. Department of Defense and U.S. Department of Veterans Affairs: Effectiveness Research on Mind and Body Interventions." Available at: https://files.nccih.nih.gov/s3fs-public/Council_Working_Group_Final_Report_2015-01-27.pdf?8sgspn_dqheKVmoueEM48z69u8gIEDsv

National Opinion Research Center at the University of Chicago. 2018. "AP-NORC Poll: Most Americans See Drug Addiction as a Disease." Available at: http://www.apnorc.org/news-media/Pages/AP-NORC-Poll-Most-Americans-see-drug-addiction-as-a-disease.aspx

Nixon, Richard. 1971. "Special Message to the Congress on Drug Abuse Prevention and Control," *The American Presidency Project*. Available at: http://www.presidency.ucsb.edu/ws/?pid=3048.

Leung, Pamela TM, Erin M. Macdonald, Matthew B. Stanbrook, Irfan A. Dhalla, and David N. Juurlink. 2017. "A 1980 Letter on the Risk of Opioid Addiction," *New England Journal of Medicine 376*(22): 2194-2195.

O'Connell, Thomas. W., ASD(SO/LIC). Department of Defense. 2003. "Department Drug Demand Reduction Policy." Available at: https://prhome.defense.gov/ForceResiliency/DDRP/Programpolicy/

Park, Tae Woo, Richard Saitz, Dara Ganoczy, Mark A. Ilgen, and Amy S.B. Bohnert. 2015. "Benzodiazepine Prescribing Patterns and Deaths from Drug Overdose Among U.S. Veterans Receiving Opioid Analgesics: Case-Cohort Study," *bmj 350*: h2698.

Pacula, Rosalie Liccardo, Sarah B. Hunter, Allison J. Ober, Karen Chan Osilla, Raffaele Vardavas, Janice C. Blanchard, David DeVries et al. 2017. "Preventing, Identifying, and Treating Prescription Drug Misuse Among Active-Duty Service Members," *Rand Health Quarterly 7*(1).

Peck, Kelly R., Julie A. Schumacher, Paul R. Stasiewicz, and Scott F. Coffey. 2018. "Adults With Comorbid Posttraumatic Stress Disorder, Alcohol Use Disorder, and Opioid Use Disorder: The Effectiveness of Modified Prolonged Exposure," *Journal of Traumatic Stress 31*(3): 373-382.

Platteborze, Peter L., Donald J. Kippenberger, and Thomas M. Martin. 2014. "Unauthorized Drug Use in the U.S. Army Based on Medical Review Officer Evaluations," *Journal of Analytical Toxicology 38*(9): 653-659.

Porter, Jane, and Herschel Jick. 1980. "Addiction Rare in Patients Treated With Narcotics," *New England Journal of Medicine 302*(2): 123.

Powell, David, Rosalie Liccardo Pacula, and Mireille Jacobson. 2018. "Do Medical Marijuana Laws Reduce Addictions and Deaths Related to Pain Killers?" *Journal of Health Economics 58*: 9-42.

Price, Rumi Kato, Nathan K. Risk, Ashley H. Haden, Collins E. Lewis, and Edward L. Spitznagel. 2004. "Post-Traumatic Stress Disorder, Drug Dependence, and Suicidality Among Male Vietnam Veterans With a History of Heavy Drug Use," *Drug and Alcohol Dependence 76*: S31-S43.

Rasmussen, Nicolas. 2008. "America's First Amphetamine Epidemic 1929–1971: A Quantitative and Qualitative Retrospective With Implications for the Present," *American Journal of Public Health 98*(6): 974-985.

Rasmussen, Nicolas. 2011. "Medical Science and the Military: the Allies' Use of Amphetamine During World War II," *Journal of Interdisciplinary History 42*(2): 205-233.

Reisman, Anna B. 2016. "When the Medicine Doesn't Work," *Slate*. Available at: https://slate.com/technology/2016/06/purdue-pharmas-marketing-of-their-painkillers-may-have-muddied-my-relationships-with-my-patients.html

Robert Weiner Associates. 2009. "News Releases and Media Coverage of General Barry McCaffrey." Available at: http://www.weinerpublic.com/McCaffrey_NAATP_release_May_20_2009.doc

Robins, Lee N. 1974. "The Vietnam Drug User Returns. Final Report." Special Action Office Monograph, Series A, No. 2, May 1974.

Robins, Lee N., Darlene H. Davis, and Donald W. Goodwin. 1974. "Drug Use by U.S. Army Enlisted Men in Vietnam: A Follow-Up on Their Return Home," *American Journal of Epidemiology 99*(4): 235-249.

Robins, Lee N., and Sergey Slobodyan. 2003. "Post-Vietnam Heroin Use and Injection by Returning U.S. Veterans: Clues to Preventing Injection Today," *Addiction 98*(8): 1053-1060.

Robins, Lee N., J. E. Helzer, M. Hesselbrock, and E. Wish. 2010. "Vietnam Veterans Three Years After Vietnam: How Our Study Changed Our View of Heroin," *The American Journal on Addictions 19*(3): 203-211.

Rooney, Jo Ann, Undersecretary of Defense. Department of Defense. 2012. "Update to the Department of Defense Drug Testing Panel." Available at: https://prhome.defense.gov/ForceResiliency/DDRP/Programpolicy/

Rosenblum, Andrew, Lisa A. Marsch, Herman Joseph, and Russell K. Portenoy. 2008. "Opioids and the Treatment of Chronic Pain: Controversies, Current Status, and Future Directions," *Experimental and Clinical Psychopharmacology 16*(5): 405.

Ross-Degnan, Dennis, Linda Simoni-Wastila, Jeffrey S. Brown, Xiaoming Gao, Connie Mah, Leon E. Cosler, Thomas Fanning et al. 2004. "A Controlled Study of the Effects of State Surveillance on Indicators of Problematic and Non-Problematic Benzodiazepine Use in a Medicaid Population," *The International Journal of Psychiatry in Medicine 34*(2): 103-123.

Rubec, Stephanie. 2004. "Drug Use Nightmare on Canadian Forces," *Toronto Sun*. November 14, 2004.

Sabia, Joseph J., and Bill Skimmyhorn. 2019. "Beyond the Draft: Modern Warfare, All-Volunteer Forces, and Veterans' Economic Wellbeing," Working Paper, Center for Health Economics & Policy Studies, San Diego State University.

Sall, James, and Eric Rodgers. 2018. "VA/DoD Clinical Practice Guideline for Opioid Therapy for Chronic Pain," *Journal of the American Psychiatric Nurses Association 24*(4): 378.

Salzman, Carl. 1991. "The APA Task Force Report on Benzodiazepine Dependence, Toxicity, and Abuse," *American Journal of Psychiatry 148*: 151-152.

Sandbrink, Frienhelm, M.D. 2017. "VA's Acting National Program Director for Pain Management." Available at: https://newsletter.samhsa.gov/2017/06/12/opioid-pain-management-for-veterans-active-duty-military/

Schiff, Paul L. 2002. "Opium and its Alkaloids," *American Journal of Pharmaceutical Education 66*(2): 188-196.

Schoenfeld, Andrew J., John Dunn, Julia Bader, and Philip Belmon. 2013. "The Nature and Extent of War Injuries Sustained by Combat Specialty Personnel Killed and Wounded in Afghanistan and Iraq, 2003–2011," *Journal of Trauma and Acute Care Surgery 75*(2): 287-291.

Seal, Karen H., Shira Maguen, Daniel Bertenthal, Steven L. Batki, Joan Striebel, Murray B. Stein, Erin Madden, and Thomas C. Neylan. 2016. "Observational Evidence for Buprenorphine's Impact on Posttraumatic Stress Symptoms in Veterans With Chronic Pain and Opioid Use Disorder," *The Journal of Clinical Psychiatry 77*(9): 1182-1188.

Seth, Puja, Rose A. Rudd, Rita K. Noonan, and Tamara M. Haegerich. 2018. "Quantifying the Epidemic of Prescription Opioid Overdose Deaths," *American Journal of Public Health 108*(4): 500-502.

Shi, Yuyan. 2017. "Medical Marijuana Policies and Hospitalizations Related to Marijuana and Opioid Pain Reliever," *Drug and Alcohol Dependence 173*: 144-150.

Shiner, Brian, Christine Leonard Westgate, Nancy C. Bernardy, Paula P. Schnurr, and Bradley V. Watts. 2017. "Trends in Opioid Use Disorder Diagnoses and Medication Treatment Among Veterans With Posttraumatic Stress Disorder," *Journal of Dual Diagnosis 13*(3): 201-212.

Silverman, Robert, Jeanne Tuttle, and Roberto Santos. 2014. "State Prescription Drug Monitoring Programs VHA Participation [Webinar Slides]." Available at: https://www.pdmpassist.org/pdf/TTAC_Veterans_Affairs_webinar_20140319.pdf

Street, Amy E., Dawne Vogt, and Lissa Dutra. 2009. "A New Generation of Women Veterans: Stressors Faced by Women Deployed to Iraq and Afghanistan," *Clinical Psychology Review 29*(8): 685-694.

Tanielian, Terri, and Lisa H. Jaycox. 2008. *Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery*. Santa Monica, CA: Rand Corporation.

Teeters, Jenni B., Cynthia L. Lancaster, Delisa G. Brown, and Sudie E. Back. 2017. "Substance Use Disorders in Military Veterans: Prevalence and Treatment Challenges," *Substance Abuse and Rehabilitation 8*: 69.

Toblin, Robin L., Phillip J. Quartana, Lyndon A. Riviere, Kristina Clarke Walper, and Charles W. Hoge. 2014. "Chronic Pain and Opioid Use in U.S. Soldiers After Combat Deployment," *Journal of the American Medical Association: Internal Medicine 174*(8): 1400-1401.

Tompkins, D. Andrew, J. Greg Hobelmann, and Peggy Compton. 2017. "Providing Chronic Pain Management in the "Fifth Vital Sign" Era: Historical and Treatment Perspectives on a Modern-Day Medical Dilemma," *Drug and Alcohol Dependence 173*: S11-S21.

Tosti, Padideh. 2007. "Global Illicit Sectors: An Analysis of Drugs in International Relations," PhD. diss., London School of Economics and Political Science (United Kingdom).

Turk, Dennis C., Michael C. Brody, and E. Akiko Okifuji. 1994. "Physicians' Attitudes and Practices Regarding the Long-Term Prescribing of Opioids for Non-Cancer Pain," *Pain 59*(2): 201-208.

United Nations Office on Drugs and Crime. 2007. "Afghanistan Opium Survey." Available at: https://www.unodc.org/documents/crop-monitoring/Afghanistan-Opium-Survey-2007.pdf

U.S. Department of Defense. 2017. "House Report 114–537, Page 174, Accompanying H.R. 4909, the National Defense Authorization Act for Fiscal Year 2017: Report on Prescription Opioid Abuse and Effects on Readiness." Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwjX3eWzs73bAhU3CDQIHarQAUEQFggzMAE&url=https%3A%2F%2Fhealth.mil%2FReference-Center%2FReports%2F2017%2F10%2F29%2FPrescription-Opioid-Abuse-and-Effects-on-Readiness&usg=AOvVaw3nmTmRD-Dr-NwHjK5-tInC

U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality. 2018. "National Survey on Drug Use and Health 2016 (NSDUH-2016-DS0001)." Available at: https://datafiles.samhsa.gov/

U.S. Department of Veterans Affairs. 2013. "Disclosure to Participate in State Prescription Drug Monitoring Programs. Interim Final Rule," *Federal Register 78*(28): 9589.
U.S. Department of Veterans Affairs. 2018. "Department of Veterans Affairs Opioid Prescribing Data 2012 -- 2018 [Data set]." Available at: https://www.data.va.gov/story/department-veterans-affairs-opioid-prescribing-data

U.S. Food and Drug Administration. 2016. "FDA Warns About Serious Risks and Death When Combining Opioid Pain or Cough Medicines With Benzodiazepines; Requires Its Strongest Warning."

Veterans Heath Administration. 2018. Alleged Inappropriate Controlled Substance Prescribing Practices at a Veterans Integrated Service Network 20 Medical Facility. Available at: https://www.va.gov/oig/pubs/VAOIG-16-05323-200.pdf

Veterans Affairs Prescription Data Accountability Act. 2017. Available at: https://www.congress.gov/115/plaws/publ86/PLAW-115publ86.pdf

Volkow, Nora D., and Thomas A. McLella. 2011. "Curtailing Diversion and Abuse of Opioid Analgesics Without Jeopardizing Pain Treatment," *Journal of the American Medical Association 305*(13): 1346-1347.

Wenger, Jennie W., Caolionn O'Connell, and Linda Cottrell. 2018. "Examination of Recent Deployment Experience Across the Services and Components," RAND Corporation.

World Health Organization. 1957. "Expert Committee on Addiction-Producing Drugs, Seventh Report. World Health Organization Technical Report," *116*: 9–10.

Table 1A: Add Health Summary Statistics by Combat Assignment

	All	Combat Zone Deployment = 1	Combat Zone Deployment = 0	Enemy Firefight = 1	Enemy Firefight = 0
Dependent Variables					
Prescription Painkiller	0.093	0.099	0.076	0.124	0.075
	(0.291)	(0.299)	(0.267)	(0.331)	(0.264)
Painkiller Abuse	0.129	0.130	0.127	0.143	0.118
	(0.336)	(0.337)	(0.335)	(0.351)	(0.323)
Combat Service Variables					
Combat Zone Deployment	0.755	1.000	0.000	1.000	1.000
	(0.430)	0.000	0.000	0.000	0.000
Combat Zone with Enemy Firefight	0.367	0.486	0.000	1.000	0.000
	(0.483)	(0.501)	0.000	0.000	0.000
Combat Zone without Enemy Firefight	0.388	0.514	0.000	0.000	1.000
	(0.488)	(0.501)	0.000	0.000	0.000
Combat Zone with War Wounding	0.089	0.118	0.000	0.181	0.059
	(0.285)	(0.323)	0.000	(0.386)	(0.236)
Combat Zone without War Wounding	0.666	0.882	0.000	0.819	0.941
	(0.472)	(0.323)	0.000	(0.386)	(0.236)
Non-Combat Zone Deployment	0.245	0.000	1.000	0.000	0.000
	(0.430)	0.000	0.000	0.000	0.000
Observations	482	364	118	177	187

Standard deviations in parentheses. The means are generated using data for males drawn from Wave IV of the National Longitudinal Study of Adolescent to Adult Health.

Table 1B: DOD-HRB Summary Statistics by Combat Assignment

	All	Enemy Firefight = 1	Enemy Firefight = 0	Army	Marines	Navy	Air Force
Dependent Variables							
Prior-Month Painkiller	0.129	0.151	0.106	0.185	0.117	0.106	0.116
	(0.335)	(0.358)	(0.307)	(0.389)	(0.322)	(0.308)	(0.320)
Prior-Month Painkiller Abuse	0.089	0.107	0.070	0.133	0.084	0.081	0.066
	(0.285)	(0.310)	(0.254)	(0.339)	(0.277)	(0.272)	(0.248)
Prior-Month Heroin	0.006	0.012	0.001	0.010	0.008	0.005	0.003
	(0.079)	(0.107)	(0.030)	(0.100)	(0.089)	(0.071)	(0.057)
Combat Service Variables							
Enemy Firefight	0.515	1.000	0.000	0.805	0.706	0.220	0.443
	(0.500)	0.000	0.000	(0.396)	(0.456)	(0.414)	(0.497)
War Wounding	0.052	0.099	0.002	0.116	0.064	0.026	0.016
	(0.221)	(0.298)	(0.042)	(0.320)	(0.244)	(0.160)	(0.127)
Restricted Physical Activity	0.389	0.440	0.335	0.497	0.420	0.332	0.337
	(0.488)	(0.496)	(0.472)	(0.500)	(0.494)	(0.471)	(0.473)
Witness Death	0.365	0.634	0.083	0.626	0.482	0.196	0.241
	(0.482)	(0.482)	(0.276)	(0.484)	(0.500)	(0.397)	(0.428)
Witness Ally Injury or Death	0.227	0.427	0.017	0.454	0.320	0.092	0.114
	(0.419)	(0.495)	(0.129)	(0.498)	(0.466)	(0.289)	(0.317)
Observations	11542	5948	5594	2563	2507	3374	3098

Standard deviations in parentheses. The means are generated using data for males drawn from the 2008 Department of Defense Health and Related Behaviors Survey.

Table 2: Evidence on the Exogeneity of Deployment Assignment, Add Health

	Combat Assignment vs No Combat Assignment	*Enemy Firefight vs No Enemy Firefight*	*Enemy Firefight vs No Combat Assignment*
	(1)	(2)	(3)
Pre-Deployment Ever Drug Use	-0.055	0.059	-0.053
	(0.042)	(0.050)	(0.057)
Wave 1 Height	0.005	0.008	0.012
	(0.008)	(0.009)	(0.010)
Wave 1 Weight	-0.001	-0.000	-0.002
	(0.001)	(0.001)	(0.001)
Wave 1 Protestant	0.002	0.020	0.041
	(0.075)	(0.090)	(0.110)
Wave 1 Catholic	0.059	0.032	0.052
	(0.083)	(0.101)	(0.124)
Wave 1 Other Religion	0.062	0.011	0.149
	(0.136)	(0.167)	(0.229)
F-test (p-value) for Religion Indicators	*0.456 (0.714)*	*0.0410 (0.989)*	*0.145 (0.933)*
Age in Years	0.322	-0.252	0.260
	(0.355)	(0.452)	(0.467)
Age in Years Squared	-0.006	0.004	-0.005
	(0.006)	(0.008)	(0.008)
F-test (p-value) for Age	*0.514 (0.600)*	*0.833 (0.437)*	*0.249 (0.780)*
Race: Black	0.022	-0.108	-0.072
	(0.059)	(0.073)	(0.088)
Race: Other	0.081	-0.057	0.041
	(0.065)	(0.073)	(0.133)
F-test (p-value) for Race	*0.551 (0.649)*	*2.187 (0.0935)*	*0.412 (0.745)*
Race: Hispanic	-0.005	-0.164**	-0.054
	(0.055)	(0.074)	(0.103)
Some College	0.028	-0.011	0.028
	(0.055)	(0.060)	(0.084)
College	0.105	0.018	0.065
	(0.085)	(0.101)	(0.148)
F-test (p-value) for Education	*0.814 (0.445)*	*0.0738 (0.929)*	*0.0979 (0.907)*
Wave 1 PPVTS	-0.001	-0.002	-0.003
	(0.002)	(0.002)	(0.002)

	Combat Assignment vs No Combat Assignment	*Enemy Firefight vs No Enemy Firefight*	*Enemy Firefight vs No Combat Assignment*
	(1)	(2)	(3)
$19K=<Parental Income <$28K	-0.030	-0.002	-0.065
	(0.090)	(0.098)	(0.141)
$28K=<Parental Income <$36K	0.027	0.060	0.066
	(0.078)	(0.095)	(0.121)
$36K=<Parental Income <$45K	0.071	0.006	0.084
	(0.095)	(0.095)	(0.140)
$45K=<Parental Income <$56K	0.096	0.057	0.113
	(0.083)	(0.091)	(0.124)
$56K=<Parental Income <$83K	0.183	0.104	0.246
	(0.112)	(0.117)	(0.166)
$83K=<Parental Income	0.136	0.096	0.224
	(0.111)	(0.143)	(0.194)
F-test (p-value) for Parental Income	*0.994 (0.433)*	*0.331 (0.920)*	*0.836 (0.545)*
Parents: Married	-0.116	-0.065	-0.254
	(0.096)	(0.144)	(0.172)
Parents: Divorced, Separated or Widowed	-0.121	-0.051	-0.253
	(0.102)	(0.153)	(0.169)
F-test (p-value) for Parental Marital Status	*0.781 (0.460)*	*0.116 (0.891)*	*1.162 (0.317)*
Mothers Education: High School	-0.005	-0.032	-0.006
	(0.101)	(0.078)	(0.116)
Mothers Education: Above High School	-0.029	-0.007	0.029
	(0.095)	(0.082)	(0.132)
F-test (p-value) for Parental Education	*0.146 (0.864)*	*0.162 (0.851)*	*0.169 (0.845)*
One sibling	0.046	0.086	0.041
	(0.103)	(0.165)	(0.158)
Two siblings	0.058	0.106	0.074
	(0.112)	(0.182)	(0.197)
Three siblings	0.031	0.083	0.004
	(0.107)	(0.166)	(0.177)
Four siblings	0.012	0.088	-0.017
	(0.104)	(0.167)	(0.166)
Five or more siblings	0.011	0.067	0.005
	(0.105)	(0.155)	(0.179)
F-test (p-value) for Number of Siblings	*0.182 (0.969)*	*0.0936 (0.993)*	*0.246 (0.941)*
Joint F-test (p-value) for all covariates	*0.900 (0.616)*	*0.966 (0.523)*	*1.389 (0.119)*
Observations	482	482	295

Notes: Standard errors clustered on the school are in parentheses, *** p<0.01, ** p<0.05, * p<0.1 Each model includes controls for military-specific variables, including binary indicators for current active-duty military service status, total service length, military rank, branch of service, timing of service, and occupation. Coefficient(s) and standard error(s) are separately estimated for each variable (group). Each specification also includes dummies for missing information. The sample is comprised of male servicemembers only.

Table 3: The Effect of Combat on Prescription Pain Reliever Use and Abuse, Add Health

	(1)	(2)
	Prescription Painkiller	Painkiller Abuse
Panel I: Military Controls		
Combat Zone Deployment	0.036	0.070**
	(0.030)	(0.031)
Panel II: Panel I + Individual and Family Controls		
Combat Zone Deployment	0.046	0.071**
	(0.032)	(0.034)
Panel III: Panel II + Pre-Enlistment Drug Use		
Combat Zone Deployment	0.049	0.081**
	(0.033)	(0.034)
Panel IV: All Controls		
Combat Zone with Enemy Firefight	0.074**	0.074*
	(0.037)	(0.041)
Combat Zone without Enemy Firefight	0.025	0.088**
	(0.040)	(0.040)
Panel V: All Controls		
Combat Zone with War Wounding	0.255***	0.057
	(0.073)	(0.068)
Combat Zone without War Wounding	0.029	0.084**
	(0.033)	(0.035)
Observations	482	480

Robust standard errors corrected for clustering on the school are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Military Controls include binary indicators for current active-duty military service status, total service length, military rank, branch of service, service exclusively after September 11, and occupation. Individual and family controls include height, weight, religion indicators, age, age squared, race/ethnicity indicators, Wave 1 Picture Vocabulary Test Score, parental income dummies, parental marital status indicators, maternal education, and number of siblings indicators. Models also include missing dummy categories for each of the control variables with missing information. The sample is comprised of men only.

Table 4A: The Effect of Combat on Opioid Use and Abuse, DOD HRB Survey

	(1)	(2)	(3)
	Prior-Month Painkiller Use	Prior-Month Painkiller Abuse	Prior-Month Heroin
Panel I: All			
Enemy Firefight	0.027***	0.031***	0.014***
	(0.006)	(0.007)	(0.003)
Observations	11,412	11,501	11,512
Panel II: Army			
Enemy Firefight	0.025*	0.042*	0.016
	(0.013)	(0.022)	(0.009)
Observations	2,537	2,555	2,558
Panel III: Marines			
Enemy Firefight	0.049***	0.045***	0.018
	(0.007)	(0.008)	(0.009)
Observations	2,472	2,494	2,498
Panel IV: Navy			
Enemy Firefight	0.030**	0.040**	0.021**
	(0.011)	(0.015)	(0.008)
Observations	3,338	3,364	3,366
Panel V: Air Force			
Enemy Firefight	0.012	0.012	0.006**
	(0.008)	(0.008)	(0.002)
Observations	3,065	3,088	3,090

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Table 4B: The Effect of Combat on Opioid Abuse on Intensive Margin, DOD HRB Survey

	(1)	(2)
	Prescription Drug Abuse Increased Since Enlistment	Prescription Drug Abuse Increased Since Enlistment | Any Abuse Sample
Panel I: All		
Enemy Firefight	0.018***	0.098***
	(0.004)	(0.030)
Observations	11,379	1,081
Panel II: Army		
Enemy Firefight	0.020*	0.131**
	(0.008)	(0.044)
Observations	2,526	324
Panel III: Marines		
Enemy Firefight	0.019**	0.114**
	(0.006)	(0.031)
Observations	2,469	257
Panel IV: Navy		
Enemy Firefight	0.024***	0.040
	(0.005)	(0.054)
Observations	3,324	314
Panel V: Air Force		
Enemy Firefight	0.013	0.112
	(0.008)	(0.077)
Observations	3,060	186

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only. Column (1) presents the results in the full sample. In column (2), the estimation sample is limited to those who misused prescription drugs at least once.

Table 5: The Effect of Combat on Co-Use and Abuse of Opioids, DOD HRB Survey

	(1)	(2)	(3)	(4)	(5)
	Prescription Painkiller & No Opioid Abuse	Painkiller Abuse & No Prescription	Prescription Painkiller & Abuse	Heroin & No Prescription Painkiller	Heroin & Prescription Painkiller
Enemy Firefight	0.0109***	0.0145***	0.0154***	0.0066***	0.0068***
	(0.0036)	(0.0047)	(0.0034)	(0.0018)	(0.0019)
Dependent Var. Mean	0.0990	0.0587	0.0287	0.0031	0.0031
Observations	11,400	11,501	11,501	11,501	11,501

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Table 6: The Effect of Combat on Opioid Use and Abuse by Age and Gender, DOD HRB Survey

	(1)	(2)	(3)
	Prior-Month Painkiller Use	Prior-Month Painkiller Abuse	Prior-Month Heroin
Panel I: Ages 18 to 24			
Enemy Firefight	0.055***	0.057***	0.044***
	(0.015)	(0.014)	(0.012)
Observations	2,530	2,553	2,556
Panel II: Ages 25 to 32			
Enemy Firefight	0.026**	0.029***	0.008**
	(0.010)	(0.010)	(0.003)
Observations	3,843	3,873	3,879
Panel III: Ages 33 to 50			
Enemy Firefight	0.014*	0.024***	0.004**
	(0.008)	(0.008)	(0.001)
Observations	5,039	5,075	5,077
Panel IV: Women			
Enemy Firefight	0.038**	0.007	0.008*
	(0.015)	(0.016)	(0.004)
Observations	3,162	3,184	3,183
Panel V: Enlisted			
Enemy Firefight	0.038***	0.042***	0.017***
	(0.007)	(0.008)	(0.004)
Observations	8,745	8,814	8,824
Panel VI: Officer			
Enemy Firefight	-0.003	-0.002	0.002*
	(0.013)	(0.008)	(0.001)
Observations	2,667	2,687	2,688

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Table 7: The Effect of Combat Injuries and Death Exposures on Opioid Use and Abuse, DOD HRB Survey

	(1)	(2)	(3)
	Prior-Month Painkiller Use	Prior-Month Painkiller Abuse	Prior-Month Heroin
Panel I: Wounding			
Wounded	0.113***	0.122***	0.088***
	(0.014)	(0.018)	(0.022)
Observations	11,280	11,365	11,377
Panel II: Witnessed Death			
Witnessed Death or Injury	0.034***	0.039***	0.015***
	(0.004)	(0.007)	(0.003)
Observations	11,315	11,402	11,414
Panel III: Ally Hurt or Dead			
Witness Ally Death	0.043***	0.058***	0.024***
	(0.009)	(0.008)	(0.005)
Observations	11,332	11,420	11,432

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Table 8: The Impact of Deployment Assignment, Number of Deployments, and Deployment Length on Opioid Use and Abuse, DOD HRB Survey

	(1)	(2)	(3)	(4)
Panel I: Prior-Month Painkiller				
Enemy Firefight	0.045***			0.044***
	(0.009)			(0.009)
Number of Post-9/11 Deployments		0.003		-0.000
		(0.002)		(0.002)
Months Deployed Last Year			0.002*	0.001
			(0.001)	(0.001)
Observations	11,412	11,349	11,320	11,291
Panel II: Prior-Month Painkiller Abuse				
Enemy Firefight	0.038***			0.033***
	(0.007)			(0.007)
Number of Post-9/11 Deployments		0.005***		0.002
		(0.001)		(0.002)
Months Deployed Last Year			0.004***	0.003**
			(0.001)	(0.001)
Observations	11,501	11,436	11,406	11,375
Panel III: Heroin				
Enemy Firefight	0.018***			0.017***
	(0.003)			(0.003)
Number of Post-9/11 Deployments		0.002		0.001
		(0.001)		(0.001)
Months Deployed Last Year			0.001**	0.001
			(0.000)	(0.000)
Observations	11,445	11,379	11,350	11,319

Notes: Standard errors clustered on the stratum are in parentheses. Statistically significant at *10%, **5%, ***1%. Regressions control for military rank, branch of service, branch-specific major command indicators, education indictors, age, age squared, and race/ethnicity dummies. The sample includes male servicemembers only.

Table 9: Examining Mechanisms that Mediate Effect of Enemy Firefight on Opioid Use and Abuse, DOD HRB Survey

	(1)	(2)	(3)
	Prior-Month Painkiller	Prior-Month Painkiller Abuse	Prior-Month Heroin
Panel I: Baseline Estimates			
Enemy Firefight	0.029***	0.031***	0.013***
	(0.006)	(0.007)	(0.003)
Panel II: Controlling for Wounding			
Enemy Firefight	0.019***	0.022***	0.006***
	(0.006)	(0.006)	(0.001)
Wounded	0.111***	0.109***	0.086***
	(0.015)	(0.018)	(0.021)
Panel III: Controlling for Restricted Activity			
Enemy Firefight	0.021***	0.029***	0.013***
	(0.006)	(0.007)	(0.003)
Restricted Physical Activity	0.163***	0.056***	0.008***
	(0.011)	(0.008)	(0.002)
Panel IV: Controlling for PTSD			
Enemy Firefight	0.021***	0.025***	0.011***
	(0.006)	(0.007)	(0.003)
PTSD	0.113***	0.087***	0.037***
	(0.012)	(0.014)	(0.007)
Panel V: Controlling for Witnessing War			
Enemy Firefight	0.011	0.009	0.005***
	(0.008)	(0.007)	(0.002)
Witnessed Death or Injury	0.016*	0.013*	0.002*
	(0.008)	(0.007)	(0.001)
Witness Ally Death	0.030**	0.044***	0.020***
	(0.012)	(0.008)	(0.005)
Panel VI: Controlling for All Channels			
Enemy Firefight	0.005	0.006	0.003**
	(0.007)	(0.007)	(0.001)
Wounded	0.067***	0.074***	0.078***
	(0.014)	(0.017)	(0.019)
Restricted Physical Activity	0.156***	0.050***	0.005***
	(0.010)	(0.008)	(0.001)
PTSD	0.080***	0.066***	0.027***
	(0.010)	(0.013)	(0.005)
Witnessed Death or Injury	0.007	0.008	-0.001
	(0.008)	(0.007)	(0.001)
Witness Ally Death	0.003	0.022***	0.004**
	(0.013)	(0.007)	(0.002)
Observations	11,044	11,118	11,126

Robust standard errors corrected for clustering on the stratum are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Table 10: The Effect of Combat on Other Central Nervous Systems Depressants and Joint Use with Opioids, DOD HRB Survey

	(1) Prior-Month Depression/Anxiety /Sleep Medicine	(2) Prior-Month Sedative Abuse	(3) Prior-Month Tranquilizer Abuse	(4) Prior-Month Painkiller & Sedative Abuse	(5) Prior-Month Painkiller & Tranquilizer Abuse
Enemy Firefight	0.030***	0.020***	0.023***	0.018***	0.019***
	(0.005)	(0.004)	(0.005)	(0.003)	(0.005)
Dependent Var. Mean	0.0358	0.0138	0.0259	0.0110	0.0223
Observations	11,437	11,496	11,497	11,501	11,501

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Appendix Table 1: Exploring Degree of Bias in HRB Survey Estimates using Add Health and Xs Available in Both Datasets

	(1)	(2)
	Prescription Painkiller	Painkiller Abuse
Panel I: Enemy Firefight		
DOD-HRB Controls		
Combat Zone with Enemy Firefight	0.064*	0.045
	(0.033)	(0.037)
Combat Zone without Enemy Firefight	0.008	0.053
	(0.034)	(0.038)
Full Controls		
Combat Zone with Enemy Firefight	0.074**	0.074*
	(0.037)	(0.041)
Combat Zone without Enemy Firefight	0.025	0.088**
	(0.040)	(0.040)
Observations	482	480
Panel II: Wounding		
DOD-HRB Controls		
Combat Zone with War Wounding	0.222***	0.039
	(0.070)	(0.053)
Combat Zone without War Wounding	0.012	0.050
	(0.029)	(0.033)
Full Controls		
Combat Zone with War Wounding	0.255***	0.057
	(0.073)	(0.068)
Combat Zone without War Wounding	0.029	0.084**
	(0.033)	(0.035)
Observations	482	480

Standard errors corrected for clustering on the school are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All models control for age, age squared, race/ethnicity indicators, education indicators, military rank, timing of military service, and branch of service. Models also include missing dummy categories for each of the control variables. In every model estimated those who are deployed to a non-combat zone constitute the comparison group.

Appendix Table 2: The Effect of Enemy Firefight on Painkiller Abuse and Heroin Use by Legitimate Prescription Painkiller Receipt

	(1)	(2)	(3)	(4)
	Prior-Month Painkiller Abuse	Prior-Month Painkiller Abuse	Prior-Month Heroin	Prior-Month Heroin
Enemy Firefight	0.0588***	0.0193***	0.0451***	0.0078***
	(0.0207)	(0.0055)	(0.0139)	(0.0021)
Observations	1,467	9,933	1,468	9,934
Dependent Var. Mean	0.2256	0.0679	0.0245	0.0036
Sample	Prior-Month Prescription Painkiller = 1	Prior-Month Prescription Painkiller = 0	Prior-Month Prescription Painkiller = 1	Prior-Month Prescription Painkiller = 0

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Appendix Table 3: DOD-HRB Summary Statistics by Combat Assignment, Female Sample

	All	Enemy Firefight = 1	Enemy Firefight = 0	Army	Marines	Navy	Air Force
Dependent Variables							
Prior-Month Painkiller	0.180	0.215	0.159	0.241	0.197	0.162	0.144
	(0.385)	(0.411)	(0.365)	(0.428)	(0.398)	(0.368)	(0.352)
Prior-Month Painkiller Abuse	0.102	0.117	0.093	0.160	0.103	0.088	0.073
	(0.303)	(0.321)	(0.290)	(0.367)	(0.304)	(0.283)	(0.260)
Prior-Month Heroin	0.003	0.007	0.001	0.004	0.006	0.003	0.001
	(0.056)	(0.086)	(0.023)	(0.064)	(0.075)	(0.057)	(0.032)
Combat Service Variables							
Enemy Firefight	0.381	1.000	0.000	0.670	0.489	0.144	0.333
	(0.486)	0.000	0.000	(0.470)	(0.500)	(0.351)	(0.472)
War Wounding	0.020	0.050	0.002	0.039	0.028	0.014	0.008
	(0.141)	(0.219)	(0.045)	(0.195)	(0.166)	(0.119)	(0.089)
Restricted Physical Activity	0.424	0.491	0.382	0.521	0.525	0.354	0.364
	(0.494)	(0.500)	(0.486)	(0.500)	(0.500)	(0.478)	(0.481)
Witness Death	0.218	0.445	0.081	0.330	0.214	0.170	0.185
	(0.413)	(0.497)	(0.272)	(0.470)	(0.411)	(0.376)	(0.388)
Witness Ally Injury or Death	0.107	0.255	0.017	0.212	0.115	0.055	0.076
	(0.309)	(0.436)	(0.130)	(0.409)	(0.319)	(0.227)	(0.264)
Observations	3198	1218	1980	725	536	925	1012

Standard deviations in parentheses. The means are generated using data for males drawn from the 2008 Department of Defense Health and Related Behaviors Survey.

Appendix Table 4: Differentiating the Effect of Enemy Firefight With vs. Without Wounding, DOD HRB

	(1) Prior-Month Painkiller	(2) Prior-Month Painkiller Abuse	(3) Prior-Month Heroin
Enemy Firefight with Wounding	0.124***	0.136***	0.093***
	(0.015)	(0.019)	(0.023)
Enemy Firefight without Wounding	0.018***	0.020***	0.005***
	(0.006)	(0.006)	(0.001)
Observations	11,280	11,365	11,377

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Appendix Table 5: The Impact of Enemy Firefight on Wounding, PTSD and Witnessing War Casualties, DOD HRB

	(1) War Wounding	(2) Restricted Physical Activity	(3) PTSD	(4) Witness Death	(5) Witness Ally Injury or Death
Enemy Firefight	0.078***	0.054***	0.065***	0.466***	0.329***
	(0.012)	(0.012)	(0.009)	(0.020)	(0.024)
Observations	11,338	11,418	11,366	11,373	11,391

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.

Appendix Table 6: Interactive Effect of PTSD and War Injuries on Opioid Use and Abuse, DOD HRB

	(1) Prior-Month Painkiller	(2) Prior-Month Painkiller Abuse	(3) Prior-Month Heroin
Panel I: Control for Wounding and PTSD			
Enemy Firefight	0.015**	0.013**	0.004**
	(0.007)	(0.006)	(0.002)
War Wounding	0.092***	0.089***	0.081***
	(0.014)	(0.017)	(0.020)
PTSD	0.103***	0.078***	0.028***
	(0.012)	(0.014)	(0.005)
Observations	11,137	11,211	11,219
Panel II: PTSD and Wounding Interaction			
Enemy Firefight	0.015**	0.014**	0.004**
	(0.007)	(0.006)	(0.002)
War Wounding	0.062***	0.047**	0.019**
	(0.019)	(0.018)	(0.009)
PTSD	0.090***	0.059***	0.001
	(0.016)	(0.013)	(0.002)
War Wounding*PTSD	0.096*	0.133**	0.197***
	(0.053)	(0.050)	(0.044)
Observations	10,989	11,061	11,069

Robust standard errors corrected for clustering on the stratum are in parentheses. Number of observations is in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Each model controls for military rank, branch of service, branch specific major command indicators, education dummies, age, age squared and race/ethnicity dummies. The sample is comprised of men only.