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John J. Ridgway Date

Service Era Risk Factors for Non-Medical Opioid Use Among United States Military Veterans 2017-2019

By

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Master of Public Health

Executive Master of Public Health

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By

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B.S., American Military University, 2013

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An abstract of
A thesis submitted to the faculty of the
Rollins School of Public Health of Emory University
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2022

Abstract

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By John Ridgway

Objective: The opioid epidemic is a major problem among United States military veterans; however, little is known about how the prevalence of opioid misuse among veterans has changed over time. We sought to determine the prevalence of, and risks associated with non-medical prescription opioid misuse among veterans who served prior to and after September 11, 2001 (9/11).

Methods: We conducted a cross-sectional study and collected demographic and risk factor data for veterans who served on active duty (n=5,675) from the 2017-2019 Substance Abuse and Mental Health Services Administration (SAMHSA) National Survey on Drug Use and Health (NSDUH) surveys. We identified those who self-reported using prescription opioids in a manner not directed by a physician. We used logistic regression to obtain unadjusted and adjusted prevalence ratios of non-medical opioid misuse (NMOU) risk factors for veterans who served prior to and after 9/11.

Results: 3,609 veterans served pre-9/11 and 2,066 served post-9/11. Multiple factors were associated with opioid misuse, including serving post-9/11 (OR=1.76), female sex (OR=2.25), urban living environment (OR=2.81), recent drug or alcohol treatment (OR=6.23), heavy alcohol use (OR=3.75), and increased psychological distress (OR=3.36). In adjusted analysis, prevalence of NMOU was increased among pre-9/11 veterans who were non-Hispanic white (OR=4.49), engaged in risky behavior (OR=2.45), and reported heavy alcohol use (OR=3.25). Prevalence of NMOU among post-9/11 veterans was higher among those who lived in a large metro area (OR=6.83), lived in poverty (OR=2.54), and experienced increased psychological distress in the previous year (OR=2.41).

Conclusions: We found significant differences in non-medical prescription opioid use among veterans who served prior to and post 9/11. Those who served post 9/11 are more likely to misuse opioids. Female veterans were more likely than male veterans to misuse prescription opioids, and there was no evidence of statistical interaction of service era with gender. Statistical power was limited due to the small number of opioid misuse cases in this study; larger studies focusing on expanded demographic samples and military-specific risk factors are warranted. Further, there is a need for continued research on non-medical prescription opioid use risk factors for veterans, particularly as prescribing guidelines continue to evolve.

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Table of Contents

CHAPTER I: INTRODUCTION

The opioid epidemic is one of the nation's leading public health concerns. There was a total of 49,860 opioid related deaths in 2019. Of those, 14,139 were attributable to prescription and synthetic opioids and 8,263 were attributable to prescription opioids and methadone alone. Total deaths rose to 91,799 in 2020 with 7,790 attributable to prescription and methadone alone (1). Opioid-related deaths are increasing overall, as are deaths attributable to synthetic opioids, primarily fentanyl. While heroin related deaths decreased slightly, all other opioid related fatality categories experienced a rise in deaths during the first year of the COVID pandemic. As of 2019 there were an estimated 9.7 million Americans who had misused prescription pain relievers in the previous year and another 745,000 who had used heroin (2). In the 2010's nearly 70% of those who used heroin had used prescription opioids first (3). The Covid-19 pandemic has exacerbated the crisis with opioid misuse and opioid-involved overdoses increasing to record levels (4).

Veterans comprise one of the vulnerable populations most affected by the opioid epidemic. Among veterans, opioid overdose rates increased by 69% between 2010 and 2016 from 14.47 to 21.08 per 100,000 with natural and semi-synthetic opioids accounting for more than 62% of overdoses (5). Leadership in the Department of Defense (DoD) and the Veteran's Administration (VA) has taken direct measures to combat the crisis among the veteran population. Both organizations have implemented programs and policies that have greatly reduced rates of opioid prescriptions, long-term prescriptions for opioids, and opioid dosage (6). DoD pain management and opioid

prescribing guidelines were changed in 2017 to further reduce potential harms from natural and non-synthetic opioids (6).

As of this writing, the CDC is considering amending the opioid prescription guidelines put into place in 2016 to allow for more personalized approaches to prescribing and dispensing conversations between prescribers and patients. Whether DoD would change their guidelines based on CDC recommendations is currently unknown. As COVID-related precautions are expected to ease and daily life moves into a post-pandemic era, it is imperative to better understand risk factors for opioid misuse to ensure timely identification and intervention. As knowledge has grown and resources for those who misuse opioids become widely available again, examining data prior to the Covid-19 pandemic may be a useful source for identifying these risk factors.

A key question is whether there is an association between veterans who have been activated during pre- and post-9/11 service periods. The purpose of this thesis is to evaluate the association between service in the United States military and risk factors associated with NMOU based upon combat experience and service era in which they served. Knowing these risk factors could help VA prescribers more effectively dispense of and detect patients at high risk of misusing opioids or overdose. We hypothesize that younger post-9/11 veterans will be at greater risk with higher prevalence of use among poorer, unmarried, white, combat experienced males. Additionally, psychological distress, partaking in subjectively risky behaviors, and prior substance use and treatment will be a strong predictor for opioid misuse among both pre- and post-9/11 groups of veterans.

Background

Military veterans represent a unique subset of the American population as they are more prone to be exposed to physically demanding high-stress situations and experience greater rates of behavioral health conditions than their civilian counterparts. Studies have suggested a link between opioid misuse and young age, heavy tobacco use, prior drug or alcohol rehabilitation or use, stressful circumstances, and a history of severe depression (7-10). Recognizing these and other associated risk factors in veterans is vital to preventing misuse and treating addiction in the 250,000 veterans who are prescribed opioids (11). Prior studies have suggested opioid usage differs by military service and combat experience (12). Whether similar associations are seen in veterans who have served in different conflicts has yet to be elucidated. Myriad differences exist between the pre- and post-9/11 service era veteran including demographics of those who served in these periods as well as modes of warfare and related injuries.

According to 2018 census data, the total population of veterans in the United States is declining – the number of veterans declined by one third between the years 2000 and 2018 from 26.4 million to 18 million (13). Among the general population, young age is a commonly known risk factor for NMOU (14-16). The average age of post-9/11 veterans is 36.6 while the average age from previous conflicts is older and less commonly associated with NMOU. For example, the average age for Gulf War veterans is 49.6 years, Vietnam War is 70.8 years, and the Korean War is 86.1 years (13).

Women are continuing to increase their involvement in US armed forces and are expected to comprise 17% of all veterans by 2040 – a rise from 9.2% in 2018. As this subset of the veteran population increases, so does their exposure to risk in service thus

susceptibility to prescription opioid misuse. Women are more likely to experience chronic pain, to be prescribed opioid medications at higher dosages and for longer periods of time (17-19).

Finally, opioids are most frequently prescribed to treat moderate to severe pain (20). Post-9/11 veterans have the highest probability (43%) of having a service-connected disability – an injury, disease, or disability that was the result of service in the armed forces – than any other service era. Post-9/11 veterans also have the highest probability of any service era to have a disability rating over 70 (39.3%), that can be the severity of one disability, or a combination of two or more disabilities (13). Service-connected disability can also be awarded for psychological stress such as a post-traumatic stress disorder (PTSD) diagnosis. According to VA estimates, approximately 11-20% of post-9/11 service veterans have PTSD, compared to 12% of Gulf War era and 15% of Vietnam era veterans (21).

Purpose of the study

To assess risk factors associated with non-medical opioid use among United States military veterans based upon the period of conflict in which they served.

Public health purpose of the study

To provide further guidance in prescribing opioids or alternate non-opioid therapies.

CHAPTER II: MANUSCRIPT

Article to be submitted to *Pain Medicine* for publication

Service Era Risk Factors for Non-Medical Opioid Misuse Among United States Military Veterans 2017-2019

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Abstract

Service Era Risk Factors for Non-Medical Opioid Use Among United States Military Veterans 2017-2019
By John Ridgway

Objective: The opioid epidemic is a major problem among United States military veterans; however, little is known about how the prevalence of opioid misuse among veterans has changed over time. We sought to determine the prevalence of, and risks associated with non-medical prescription opioid misuse among veterans who served prior to and after September 11, 2001 (9/11).

Methods: We conducted a secondary analysis on the 2017-2019 Substance Abuse and Mental Health Services Administration (SAMHSA) National Survey on Drug Use and Health (NSDUH) surveys. We identified veterans (n=5,675) who self-reported using prescription opioids in a manner not directed by a physician. We used logistic regression to obtain unadjusted and adjusted prevalence ratios of non-medical opioid misuse (NMOU) risk factors for veterans who served prior to and after 9/11.

Results: 3,609 veterans served pre-9/11 and 2,066 served post-9/11. In adjusted analysis, pre-9/11 veterans saw significant increased risks with being non-Hispanic white (OR=4.49), engaging in risky behavior (OR=2.45), and heavy alcohol use (OR=3.25). Prevalence of NMOU among post-9/11 veterans was higher among those who lived in a large metro area (OR=6.83), lived in poverty (OR=2.54), and experienced increased psychological distress within the previous year (OR=2.41).

Conclusions: We found significant differences in non-medical prescription opioid use among veterans who served prior to and post 9/11. Those who served post 9/11 are more likely to misuse opioids. Statistical power was limited due to the small number of NMOU cases in this study; larger studies focusing on expanded demographic samples and military-specific risk factors are warranted. Further, there is a need for continued research on non-medical prescription opioid use risk factors for veterans, particularly as prescribing guidelines continue to evolve.

Introduction

The opioid epidemic is one of the nation's leading public health concerns today. As of 2019 there were an estimated 9.7 million Americans who had misused prescription pain relievers in the previous year and another 745,000 who had used heroin (2). In the 2010's nearly 70% of those who used heroin had used prescription opioids first (3). There was a total of 49,860 total opioid related deaths in 2019. Of those, 14,139 were attributable to prescription and synthetic opioids and 8,263 were attributable to prescription opioids and methadone alone (1). The Covid-19 pandemic has exacerbated the crisis with opioid misuse and opioid-involved overdoses increasing to record levels (4).

Veterans comprise one of the vulnerable populations most affected by the opioid epidemic. Among veterans, opioid overdose rates increased by 69% between 2010 and 2016 from 14.47 to 21.08 per 100,000 with natural and semi-synthetic opioids accounting for more than 62% of overdoses (5). Leadership in the Department of Defense (DoD) and the Veterans Administration (VA) has taken direct measures to combat the crisis among the veteran population. Both organizations have implemented programs and policies that have greatly reduced rates of opioid prescriptions, long-term prescriptions for opioids, and opioid dosage. DoD pain management and opioid prescribing guidelines were changed in 2017 to further reduce potential harms from natural and non-synthetic opioids (6).

What is not well understood is whether there is an association between veterans who have been activated during pre- and post-September 11, 2001 (9/11) service periods. Knowing these risk factors could help VA prescribers more effectively dispense

of and detect patients at high risk of misusing opioids or overdose. We hypothesize that younger post-9/11 veterans will be at greater risk with higher prevalence of use among poorer, unmarried, white, combat experienced males. Additionally, psychological distress, partaking in subjectively risky behaviors, and prior substance use and treatment will be a strong predictor for opioid misuse among both pre- and post-9/11 groups of veterans.

Background

Military veterans represent a unique subset of the American population as they are more prone to be exposed to physically demanding high-stress situations and experience greater rates of behavioral health conditions than their civilian counterparts. Studies have suggested a link between opioid misuse and risk factors common among member of the US military: young age, heavy tobacco use, prior drug or alcohol rehabilitation or use, stressful circumstances, and a history of severe depression (7-10). Young age is a commonly known risk factor for NMOU (14-16). The average age of post-9/11 veterans is 36.6 while the average age from previous conflicts is older and less commonly associated with NMOU. For example, the average age for Gulf War veterans is 49.6 years, Vietnam War is 70.8 years, and the Korean War is 86.1 years (13).

According to 2018 Census data, the total population of veterans in the United States is declined by approximately a one-third between the years 2000 and 2018 from 26.4 million to 18 million (13). Meanwhile, women are continuing to increase their involvement in the US armed forces and are expected to comprise 17% of all veterans by 2040 – a rise from 9.2% in 2018. As this subset of the veteran population increases, so does their exposure to risk in service thus susceptibility to prescription opioid misuse.

Women are more likely to experience chronic pain and to be prescribed opioid medications at higher dosages and for longer periods of time (17-19).

Finally, opioids are most frequently prescribed to treat moderate to severe pain (20). Post-9/11 veterans have the highest probability (43%) of having a service-connected disability – an injury, disease, or disability that was the result of service in the armed forces – than any other service era. Post-9/11 veterans also have the highest probability of any service era to have a disability rating over 70 (39.3%), that can be the severity of one disability, or a combination of two or more disabilities (13). Service-connected disability can also be awarded for psychological stress such as a post-traumatic stress disorder (PTSD) diagnosis. According to VA estimates, approximately 11-20% of post-9/11 service veterans have PTSD, compared to 12% of Gulf War era and 15% of Vietnam era veterans (21).

Recognizing these and other associated risk factors in veterans is vital to preventing misuse and treating addiction in the 250,000 veterans who are prescribed opioids (11). Whether similar associations are seen in veterans who have served in different conflicts has yet to be elucidated. The purpose of this thesis is to evaluate the association between service in the United States military and risk factors associated with NMOU based upon combat experience and service era in which they served. Knowing these risk factors could help VA prescribers more effectively dispense of and detect patients at high risk of misusing opioids or overdose. We hypothesize that younger post-9/11 veterans will be at greater risk with higher prevalence of use among poorer, unmarried, white, combat experienced males. Additionally, psychological distress,

partaking in subjectively risky behaviors, and prior substance use and treatment will be a strong predictor for opioid misuse among both pre- and post-9/11 groups of veterans.

Methods

Data Source, Study Design, and Population

A secondary analysis was conducted on restricted data obtained from the 2017-2019 Substance Abuse and Mental Health Service Administration (SAMHSA) National Survey on National Drug Use and Health (NSDUH). NSDUH is an annual, random, cross-sectional survey of all civilian, non-institutionalized persons 12 years of age and older and representative of all 50 states and the District of Columbia. A total of 203,448 surveys were completed for the years 2017-2019, the period used for this analysis. Inclusion criteria for this analysis encompasses all United States service veterans who were on active duty at some point during their career. Excluded from this study were those who did not serve on active duty at any point in their life prior to the completion of this study. We conducted a complete-case analysis, excluding observations with missing data removing 74 subjects – 71 with no opioid misuse and 3 with opioid misuse.

Observations were classified according to their opioid misuse (yes, or no) and NSDUH weights were applied to account for sampling design. Estimates of demography for the pre- and post-9/11 groups (age, sex, race, marital status, education level, rural-urban classification, and era of service) were generated to assess the characteristics of those who misused opioids within the previous year. Those estimates were then used to compare across both veteran groups to determine risk factors for each group.

Outcome Variable

The outcome variable of interest for this study is the misuse of prescription opioids within the previous year of the study interview. Participants were considered to have misused opioids if they reported use of prescription opioids in any manner not directed by a doctor, including use without a prescription of one's own medication; use in greater amounts, more often, or longer than told to take a drug; or use in any other way not directed by a doctor (22). The focus of this paper is based solely on behaviors within the year prior to the survey being taken.

Variables of Interest

The exposure of concern in this study was the service era in which the veterans served. In the original SAMHSA dataset service eras were divided into five categories in the dataset (before March 1961, March 1961-April 1975, May 1975-July 1990, August 1990-August 2001, and September 2001 and later). For the purposes of this paper, these categories were further collapsed into two groups: pre- and post-9/11 to account for case distribution as well as a general age range already associated with the outcome. For this study, subjects who served across both pre- and post-9/11 service periods (n=440) were included in the post-9/11 group.

Covariates

Variables were selected based on empirical research as well as general health and lifestyle data collected at Veterans Affairs Medical Centers (VAMCs). The NSDUH data were categorized into 17 age ranges upon receipt – for this study age was further reclassified into the following groups: Under 35, 35-49, and 50 and older. Sex was defined in this study as it is in NSDUH, male or female. Race categories were reduced from seven categories into: non-Hispanic White, non-Hispanic Black, Hispanic, and

Other. Marital status was recoded from four categories into three: never married, married, and previously married, which included both widowed and divorced subjects. Across variables, categories were collapsed to preserve power and interpretation of findings.

Geographic and urbanicity data were coded based on the 2013 Rural/Urban Continuum Codes and divided into three categories: Large Metro, Small Metro, and Nonmetro. Education was categorized as high school graduate or less, completed some college or an AS degree, and college graduate. Income was coded as binary as living beneath or above the poverty line. Drug and/or alcohol treatment was coded as binary as to whether the subject had been to a treatment facility for drugs, alcohol, or both.

Additional risk factors considered include substance use, criminal history, and mental health. Alcohol consumption was measured over the previous 30 days and was categorized into heavy drinking, binge drinking, drinking, but not binging, and no drinking. Smoking was defined according to the CDC as having smoked more than 100 cigarettes in their lifetime and have had at least one cigarette in the previous 30 days. Criminal history was categorized into binary categories of no arrests and at least one criminal arrest and booking. Psychological distress within the past year was measured using the K6 scale and a cutoff score of 13.

Statistical Analysis

To account for NSDUH survey design, weighted logistic regression was conducted in SAS 9.4 statistical software. Descriptive statistics were calculated on demographic data and risk factors stratified by non-medical opioid use (NMOU). Univariate odds ratios and 95% confidence intervals were generated to determine associations between

demographic and risk factors and NMOU. Prevalence values of individual opioid misuse risk factors stratified by pre- and post- 9/11 service eras were also calculated (**Table 2**).

Veterans who were never activated were omitted from this study as they were ineligible for VA health benefits. Further, 12 veterans failed to submit a valid service era and were omitted. Additionally, only complete cases were analyzed removing 74 total subjects – 3 NMOU and 71 non-NMOU. This resulted in a study sample of 5,675 veterans with 175 cases of NMOU (**Fig. *1***).

An initial weighted logistic regression model was estimated to generate the unadjusted odds of NMOU among all veterans. The association between the subject's service era, and predictive risk factors was assessed using weighted logistic regression analyses. Univariate odds ratios and 95% confidence intervals were generated to estimate each variable's risk of prescription opioid misuse among veterans who served pre- and post- 9/11.

A subsequent regression model was estimated to account for the interaction between service era and age. Significance values were compared between univariate and multivariate analyses to determine predictors remaining in the final model as well as results from the pre- and post-9/11 service period stratifications. The final model included adjustments for race, rural/urban county, living in poverty, receiving treatment or counseling for the use of alcohol or any drug, participation in subjectively risky behaviors, alcohol consumption, and serious psychological distress within the previous year. This final model was utilized for its discrimination and ability to account for age during each service period.

Results

Univariate Statistical Analysis

Between 2017 and 2019, there were 5,675 veterans who completed the NSDUH survey. In the year prior to survey completion, 175 veterans (3.1% of sample) used prescription opioids in ways other than intended by a prescribing physician. **Table *1*** provides a summary of the demographic characteristics of the participating veterans stratified by prescription opioid misuse within the past year. Significant differences were found based on era of service: veterans who served post-9/11 who were 1.76 times more likely to misuse prescription opioids compared to those who served pre-9/11 (95% CI [1.15, 2.67]). Veterans 50 years or older were 0.39 times as likely (95% CI [0.24, 0.63]) than those under 35 to misuse prescription opioids.

Married individuals were less likely to misuse opioids compared to those who have never been married (OR=1.93, 95% CI [1.04, 3.56]) or previously married (OR=1.69, 95% CI [1.06, 2,84]). Veterans living in poverty were 1.96 (95% CI [1.07, 3.58]) times more likely than those not living in poverty to misuse prescription opioids as well as those who practice subjectively risky behaviors sometimes or always (OR=2.43, 95% CI [1.66, 3.56]), and females were 2.25 times as likely males to misuse prescription opioids (95%CI [1.23, 4.13]). Veterans who have been in drug and/or alcohol treatment in the previous year were 6.23 (95% CI [2.94, 13.19]) times as likely to misuse as well as those who heavily drank alcohol (OR=3.75, 95% CI [1.96, 7.14]), binge drank (OR=2.29, 95% CI [1.17, 4.50]), or consumed any amount of alcohol (OR=2.00, 95% CI [1.04, 3.86]) compared to those who did not drink alcohol in the past month. Veterans who experienced significant psychological distress within the previous year (OR=3.36, 95% CI [2.14, 5.27]) or have been taken into custody and processed by law

enforcement or court officials within the past year (OR=4.39, 95% CI [1.99, 9.71]) are also more likely to misuse prescription opioids. Finally, there were no considerable differences in opioid misuse between those living in a large versus small metro; however, those living in a large metro area were 2.81 (95% CI [1.22, 6.51]) times as likely to misuse than those living in a non-metro area.

Multivariate Statistical Analysis

The multivariable logistic model included a term for interaction between service era and age to account for the general ages within each era. Once adjusted for, post-9/11 service era veterans were found to be significantly ($p<0.0001$) more likely to misuse prescription opioids. Utilizing the reduced regression model we found – among all veterans – females were 1.9 (adjusted Odds Ration – aOR) times ($p=0.052$) more likely to misuse prescription opioids than males (95% CI [1.00, 3.64]) while those living in non-metro counties were 0.37 times ($p=0.210$) less likely to misuse than those living in an urban county (95% CI [0.157, 0.860]). Additional risk factors associated with prescription opioid misuse include treatment or counseling for drug or alcohol use within the past year (aOR=3.64, 95% CI [1.51, 8.80]), participating in risky behaviors (aOR=2.02, 95% CI [1.28, 3.17]), and drinking alcohol (aOR=2.03, 95% CI [1.03, 3.93]) or heavy alcohol use (aOR=2.94, 95% CI [1.45, 5.93]) compared to those who do not drink. Veterans who experienced psychological distress within the previous year were 2.21 times as likely to misuse prescription opioids (95% CI [1.33, 3.69]).

Among veterans who served pre-9/11 the risk factors significantly associated with misusing prescription opioids consisted of those who conducted subjectively risky behavior sometimes or always (aOR=2.45, 95% CI [1.38, 4.34]), received drug or alcohol

treatment or counseling within the previous year (aOR=4.97, 95% CI [1.38, 17.9]), and engaged in heavy drinking (aOR=3.25, 95% CI [1.42, 7.44]). Those who identified as a race or ethnicity other than white, Black, or Hispanic were at a reduced risk of misusing prescription opioids compared to those mentioned (aOR=0.22, 95% CI [0.05, 0.94]). While not statistically significant (p=0.070), those who drank any alcohol within the past month were 2.22 times as likely to misuse prescription opioids as those who did not drink (95% CI [0.94, 5.26]). Finally, those who experienced psychological distress within the previous year (p=0.064) had increased prevalence of misusing prescription opioids (aOR=2.16, 95% CI [0.96, 4.87]).

Among post-9/11 veterans those who lived in non-metro areas had lower prevalence of opioid misuse (aOR=0.15, 95% CI [0.05, 0.40]). Factors associated with increased prevalence of misuse are those living in poverty (aOR=2.53, 95% CI [1.14, 5.62]) and those who experienced psychological distress within the past year (aOR=2.41, 95% CI [1.29, 4.49]). While not statistically significant females (p=0.081) had increased prevalence of opioid misuse (aOR=1.86, 95% CI [0.93, 3.72]) as well as those who have received treatment or counseling for the use of alcohol or any drug (p=0.083) within the previous year (aOR=2.57, 95% CI [0.88, 7.52]).

Discussion

Principal Findings

Veterans serving post-9/11 were more likely to misuse prescription opioids than their pre-9/11 counterparts. This finding supports current literature which demonstrates that younger adults, who would have served during the more recent conflicts, are more at risk of developing NMOU practices (14-16).

Evidence has shown previous alcohol or substance use disorders are associated with an increased risk of opioid misuse (23). Significant differences were found in the types of risk factors between veterans from each service era. When stratified, veterans serving prior to pre-9/11 who had received treatment or counseling for drug or alcohol use within the previous year and who reported binge drinking within the previous month had higher prevalence of opioid misuse. Pre-9/11 veterans who reported engaging in risky and thrill-seeking behaviors also had higher prevalence of opioid misuse (7).

Veterans who identified as a race other than non-Hispanic white non-Hispanic Black, or Hispanic had a decreased prevalence of NMOU. This is consistent with the literature (24) that people of color have a reduced prevalence of NMOU compared to non-Hispanic white people. However, this finding needs further exploration as there was a relatively small "other" race sample. Pre-9/11 veterans also had a slightly increased prevalence of NMOU when reporting psychological distress within the previous year. This finding agrees with Chan et al. (15) who found lower psychological distress prevalence among older adults but a stronger association between NMOU and elevated psychological distress scores.

After controlling for all other variables, prescription opioid misuse was more prevalent among United States military veterans who actively served post-9/11. This finding aligns with current literature as the average age of those who served post-9/11 is younger than those who served prior (7, 25, 26). Post-9/11 veterans who live in urban counties were at greater risk of NMOU compared to those who live in non-metro and small metro counties. Literature has been supportive of higher NMOU rates in rural

populations(27, 28) when conducted in localized studies, while nationally representative studies have shown equal or higher rates trending toward the urban population (29, 30). Higher rates of high opioid prescribing, misuse, hospitalizations, and deaths in counties with worse economic prospects (31). The poverty rate for veteran households is 6.6% compared to 13% for non-veteran households, however, the growth rate of those living in poverty is expanding more quickly among the veteran population compared to the non-veterans – 50% increase and 3% increase, respectively (32). Post-9/11 veterans who live below the poverty line had higher prevalence of NMOU compared to those who live above it.

The only significant common variable between the two groups of veterans was experiencing psychological distress within the previous year. This finding illustrates the importance of monitoring the mental health of all veterans. A validity study of the Kessler K6 non-specific distress scale by Prochaska et al. (33), however, did find the cutoff score of 13 for severe mental illness discounted mild mental illness that was also associated with an increase in substance abuse.

This study produced a novel result as we found an approximate two-fold higher prevalence of opioid misuse among female veterans who served post-9/11. Although this finding was not statistically significant the effect size merits further exploration. Men are widely reported at greater frequency of NMOU than women in the general population (34, 35), however, extraneous factors suggest a more conducive environment for misuse. For example, women more frequently obtain their first opioids via prescription (34), more likely to experience chronic pain (17), and are prescribed opioid medications at higher doses for longer periods of time (18, 19). These factors combined

suggest over-prescription of opioids to female United States veterans might lead to excess misuse compared to males.

Strengths and Limitations

This study has three main strengths. First, it combines data for the three years leading into the COVID pandemic. This allows for better prediction post-pandemic as well as for trend comparison pre- and post-pandemic. Second, this study differentiates between those who served pre- and post-9/11. Third, the NSDUH is a nationally representative survey that corresponds to current veteran demographics to include race and gender (36), allowing for better generalization to the veteran population.

There are also several limitations to this study that must be considered. First, there was a relatively small sample size when reduced to United States veterans who had been activated during their service period resulting in few observed cases. This resulted in combining groups into larger and more generalized categories restricting more specific investigations into risk factors. This limitation was further manifested by supporting data not being publicly available and largely being pre-sorted into two or more categories. Second, this study excludes many veterans: active duty military personnel, those institutionalized in group quarters (e.g., hospitals, prisons, nursing homes, and treatment centers), and those who are experiencing homelessness who also do not utilize shelters – the latter two represent a greater portion of the at-risk veteran population.

Third, the NSDUH survey utilized only collected a few military specific data points. While being able to differentiate demographic and lifestyle factors is beneficial,

service-related data would enhance the results (e.g., PTSD diagnosis, service-connected injury, deployments without exposure to combat, etc.).

Implications for PH Practice

To date, there is limited evidence for risk factors for prescription opioid misuse among veterans distinguishing between service periods. This study provides important insights into various considerations when prescribing opioids between United States military veterans who have served before and after 9/11. It is currently unclear as to whether the DoD or VA will update their policies to align with new CDC guidelines (37, 38). Regardless, prescribers should consider any veteran's service period and relevant risk factors when prescribing.

Considerations for future research

This study found significant risk factors in demographic and lifestyle behaviors, but future research needs to be conducted to examine military specific risk factors for better detection. Primarily, opioids are prescribed due to pain and veterans experience significantly higher prevalence of chronic pain than their civilian counterparts (39). This extends to mental health assessment tools as veterans are inherently subjected to a greater amount of potentially traumatizing experiences. Mental health assessment should also be considered on a continuous scale. Further, case size should be expanded to include more females and racial diversity aligning with the current makeup of the armed forces. Future research should also focus on trends in NMOU prevalence and risk factor changes following the COVID pandemic. Using the present study to compare with post-pandemic analyses may assist in identifying trends in the veteran community to better identify and mitigate risky prescribing. This will better allow for the use of non-

medication therapies as treatment options. Finally, all veterans should be considered, including those who are institutionalized, homeless, or are housed in shelters to better qualify risk factors for veterans living in different environments.

Conclusion

This study found significant differences in non-medical opioid use risk factors among veterans who served before and after 9/11. Pre-9/11 veterans who reported binge drinking habits and receiving treatment or counseling for drug or alcohol use within the previous year had higher prevalence of opioid misuse. These same veterans had reduced prevalence if they identified as a race other than Hispanic, non-Hispanic white, or non-Hispanic black. Post-9/11 veterans were found to have higher prevalence of NMOU if they live in urban counties or live below the federal poverty line. The only common risk factor for NMOU among the two groups of veterans is increased psychological distress in the previous year. Also, more research is necessary to elucidate the mechanisms leading to an increased prevalence of use among female veterans overall.

This study was conducted to account for the initial change in DoD prescribing guidelines in 2017 and a change in use patterns associated with the COVID-19 pandemic. These factors limited this study in sample and effect sizes prompting the need for further research in these and other veteran-specific risk factors. Continuous research is necessary to recognize current trends in veteran's opioid use patterns and identify those who require early intervention or alternative treatment modalities for pain.

Tables

Table 1. Univariate Analysis of Sociodemographic and Lifestyle Correlates of NMOU

		Opioid Misuse				
		Overall	***No***	***Yes***		
		n (%)	***n (%)***	***n (%)***	***ORs (95%CI)***	***p-value***
Sex						
	Male	*5003 (88.2)*	*4862 (88.4)*	*144 (80.6)*	*Ref*	-
	Female	*672 (11.8)*	*638 (11.6)*	*34 (19.4)*	*2.25 (1.23, 4.13)*	*0.0100*
Age						
	<35	*1151 (20.3)*	*1095 (19.9)*	*56 (32.0)*	*Ref*	-
	35-49	*1537 (27.1)*	*1470 (26.7)*	*67 (38.3)*	*0.89 (0.54, 1.46)*	*0.6329*
	50+	*2987 (52.6)*	*2935 (53.4)*	*52 (29.7)*	*0.39 (0.24, 0.63)*	*0.0003*
Race						
	White	*4193 (73.9)*	*4065 (73.9)*	*128 (73.1)*	*Ref*	-
	Black	*679 (12.0)*	*660 (12.0)*	*19 (10.9)*	*1.05 (0.62, 1.78)*	*0.8621*
	Hispanic	*458 (8.1)*	*442 (8.0)*	*16 (9.1)*	*0.97 (0.48, 1.93)*	*0.9179*
	Other	*345 (6.1)*	*333 (6.1)*	*12 (6.9)*	*1.02 (037, 2.84)*	*0.9696*
Marital Status						
	Married	*3357 (59.2)*	*3275 (59.5)*	*82 (46.9)*	*Ref*	-
	Never Married	*839 (14.8)*	*799 (14.5)*	*40 (22.9)*	*1.93 (1.04, 3.56)*	*0.0373*
	Previously Married	*1479 (26.1)*	*1426 (25.9)*	*53 (30.3)*	*1.69 (1.06, 2.68)*	*0.0273*
Education						
	HS or Less	*1667 (29.4)*	*1621 (29.5)*	*46 (26.3)*	*Ref*	-
	Some college/AS	*2357 (41.5)*	*2264 (41.2)*	*93 (53.1)*	*1.44 (0.84, 2.47)*	*0.1809*
	College Grad	*1651 (29.1)*	*1615 (29.4)*	*36 (20.6)*	*0.84 (0.46, 1.52)*	*0.5498*
Residence						
	Large Metro	*2093 (36.9)*	*2005 (36.5)*	*88 (50.3)*	*Ref*	-
	Nonmetro	*1258 (22.2)*	*1240 (22.5)*	*18 (10.3)*	*0.36 (0.15, 0.82)*	*0.0167*
	Small Metro	*2324 (41.0)*	*2255 (41.0)*	*69 (39.4)*	*0.73 (0.45, 1.21)*	*0.2169*
Service Era						
	Pre 9/11	*3609 (63.6)*	*3523(64.1)*	*86 (49.1)*	*Ref*	-
	Post 9/11	*2066 (36.4)*	*1977 (35.9)*	*89 (50.9)*	*1.76 (1.15, 2.67)*	*0.0097*
Combat						
	No	*3131 (55.2)*	*3034 (55.2)*	*97 (55.4)*	*Ref*	-
	Yes	*2544 (44.8)*	*2466 (44.8)*	*78 (44.6)*	*1.18 (0.70, 1.98)*	*0.5374*
Living in Poverty						
	No Poverty	*5351 (94.3)*	*5196 (94.5)*	*155 (88.6)*	*Ref*	-
	Poverty	*324 (5.7)*	*304 (5.5)*	*20 (11.4)*	*1.96 (1.07, 3.58)*	*0.0303*
Drug/Alcohol Treatment						
	No Treatment	*5575 (98.2)*	*5416 (98.5)*	*159 (90.9)*	*Ref*	-
	Treatment	*100 (1.8)*	*84 (1.5)*	*16 (9.1)*	*6.23 (2.94, 13.19)*	*<0.0001*
Risky Behavior						
	Never/Seldom	*4598 (81.0)*	*4484 (81.5)*	*114 (65.1)*	*Ref*	-
	Sometimes/Always	*1077 (19.0)*	*1016 (18.5)*	*61 (34.9)*	*2.43 (1.66, 3.56)*	*<0.0001*

Alcohol Consumption
Table 1 continued

No Use	*2184 (38.5)*	*2145 (39.0)*	*39 (22.3)*	*Ref*	-
Alcohol Use	*1894 (33.4)*	*1839 (33.4)*	*55 (31.4)*	*2.00 (1.04, 3.86)*	*0.0386*
Binge Drinking	*1119 (19.7)*	*1073 (19.5)*	*46 (26.3)*	*2.29 (1.17, 4.50)*	*0.0170*
Heavy Use	*478 (8.4)*	*443 (8.1)*	*35 (20.0)*	*3.75 (1.96, 7.14)*	*0.0001*
Criminal History					
Not Booked	*5606 (97.5)*	*5444 (97.7)*	*162(91.0)*	*Ref*	-
Booked	*107 (1.9)*	*91 (1.7)*	*16 (9.1)*	*4.39 (1.99, 9.71)*	*0.0005*
Smoker					
No	*5214 (91.9)*	*5061 (92.0)*	*153 (87.4)*	*Ref*	-
Yes	*461 (8.1)*	*439 (8.0)*	*22 (12.6)*	*1.59 (0.76, 3.33)*	*0.2123*
Psychological Distress					
No	*5069 (89.3)*	*4945 (89.9)*	*124 (70.9)*	*Ref*	-
Yes	*606 (10.7)*	*555 (10.1)*	*51 (29.1)*	*3.36 (2.14, 5.27)*	*<0.0001*

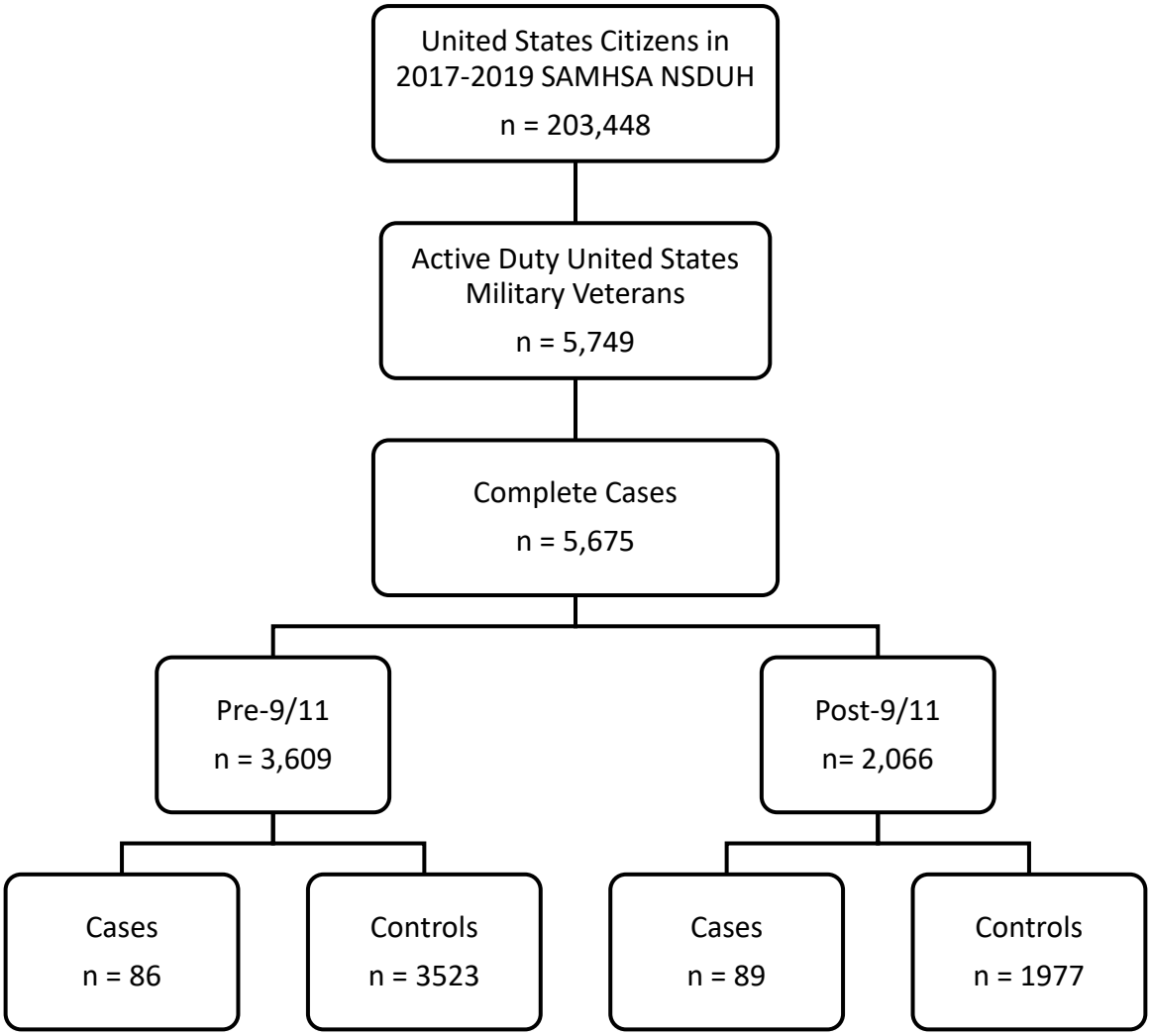
Table 2. Prevalence values of individual opioid misuse risk factors stratified by pre- and post- 9/11 service eras

	Service Era			
	Pre 9/11		Post 9/11	
	ORs (95%CI)	*p-value*	*ORs (95%CI)*	*p-value*
Sex				
Male	Ref	-	Ref	-
Female	1.83 (0.64, 5.24)	0.2591	1.92 (0.96, 3.85)	0.0656
Race				
White	Ref	-	Ref	-
Black	1.07 (0.54, 2.10)	0.8517	0.46 (0.16, 1.28)	0.1366
Hispanic	0.28 (0.07, 1.09)	0.0663	1.11 (0.45, 2.75)	0.8154
Other	0.22 (0.05, 0.94)	0.0408	1.67 (0.44, 6.33	0.4495
Marital Status				
Married	Ref	-	Ref	-
Never Married	1.56 (0.52, 4.61)	0.4262	0.72 (0.35, 1.52)	0.3944
Previously Married	1.45 (0.74, 2.83)	0.2788	0.96 (0.44, 2.10)	0.9234
Education				
HS or Less	Ref	-	Ref	-
Some college/AS	1.09 (0.54, 2.20)	0.8017	1.01 (0.51, 1.97)	0.9874
College Grad	0.66 (0.29, 1.49)	0.3169	0.65 (0.26, 1.65)	0.3672
Residence				
Large Metro	Ref	-	Ref	-
Nonmetro	0.42 (0.16, 1.11)	0.0797	0.13 0.05, 0.34)	<0.0001
Small Metro	0.80 (0.40, 1.62)	0.5343	0.54 0.30, 0.99)	0.0452
Combat				
No	Ref	-	Ref	-
Yes	1.14 (0.50 2.62)	0.7546	0.93 (0.49, 1.77)	0.8212
Living in Poverty				
No Poverty	Ref	-	Ref	-
Poverty	0.88 (0.28, 2.76)	0.8248	2.54 (1.13, 5.68)	0.0236
Drug/Alcohol Treatment				
No Treatment	Ref	-	Ref	-
Treatment	3.73 (0.80, 17.45)	0.0946	2.02 (0.64, 6.33)	0.2281

Risky Behavior				
Never/Seldom	Ref	-	Ref	-
Sometimes/Always	2.39 (1.34, 4.27)	0.0032	1.33 (0.70, 2.52)	0.3859
Alcohol Consumption				
No Use	Ref	-	Ref	-
Alcohol Use	2.37 (0.99, 5.66)	0.0517	1.60 (0.69, 3.75)	0.2751
Binge Drinking	1.63 (0.67, 3.97)	0.2810	1.83 (0.80, 4.23)	0.1526
Heavy Use	2.94 (1.24, 6.97)	0.0146	2.62 (0.90, 7.66)	0.0783
Criminal History				
Not Booked	Ref	-	Ref	-
Booked	2.15 (0.38, 12.05)	0.3858	2.40 (0.82, 7.06)	0.1109
Smoker				
No	Ref	-	Ref	-
Yes	1.22 (0.40 3.74)	0.7263	0.78 (0.34, 1.80)	0.5657
Psychological Distress				
No	Ref	-	Ref	-
Yes	1.86 (0.80, 4.34)	0.1488	2.37 (1.22, 4.60)	0.0109

Figures

Fig. 1. Flowchart of study population



CHAPTER III: CONCLUSIONS

Results

Univariate Statistical Analysis

Between 2017 and 2019, there were 5,675 veterans who completed the NSDUH survey. In the year prior to survey completion 175 veterans (3.1% of sample) used prescription opioids in ways other than intended by a prescribing physician (e.*g*., NMOU). **Error! Reference source not found.** provides a summary of the demographic characteristics of the participating veterans stratified by prescription opioid misuse within the past year. There were several significant statistical interactions between the chosen variables and prescription opioid misuse. Individuals who misused opioids were per-than those who did not. Significant differences were found based on era of service: veterans who served post-9/11 who were 1.76 times more likely to misuse prescription opioids compared to those who served pre-9/11 (95% CI [1.15, 2.67]). Those between 35-49 years old were 0.89 times as likely to misuse prescription opioids (95% CI [0.54, 1.46]) compared to those under 35. Veterans 50 years or older were 0.39 times as likely (95% CI [0.24, 0.63]) than the younger reference group to misuse prescription opioids.

Married individuals were less likely to misuse opioids compared to those who have never been married (OR=1.93, 95% CI [1.04, 3.56]) or previously married (OR=1.69, 95% CI [1.06, 2,84]). Females were 2.25 times as likely males to misuse prescription opioids (95%CI [1.23, 4.13]). Veterans living in poverty were 1.96 (95% CI [1.07, 3.58]) times more likely than those not living in poverty to misuse prescription opioids as well as those who practice subjectively risky behaviors sometimes or always (OR=2.43, 95% CI [1.66, 3.56]). Veterans who have been in drug and/or alcohol

treatment in the previous year were 6.23 (95% CI [2.94, 13.19]) times as likely to misuse as well as those who heavily drank alcohol (OR=3.75, 95% CI [1.96, 7.14]), binge drank (OR=2.29, 95% CI [1.17, 4.50]), or consumed any amount of alcohol (OR=2.00, 95% CI [1.04, 3.86]) compared to those who did not drink alcohol in the past month. Veterans who experienced significant psychological distress within the previous year (OR=3.36, 95% CI [2.14, 5.27]) or have been taken into custody and processed by law enforcement or court officials within the past year (OR=4.39, 95% CI [1.99, 9.71]) are also more likely to misuse prescription opioids. Finally, there were no considerable differences in opioid misuse between those living in a large versus small metro; however, those living in a large metro area were 2.81 (95% CI [1.22, 6.51]) times as likely to misuse than those living in a non-metro area.

Multivariate Statistical Analysis

The multivariable logistic model included a term for interaction between service era and age to account for the general ages within each era. Once adjusted for, post-9/11 service era veterans were found to be significantly ($p<0.0001$) more likely to misuse prescription opioids. The interaction term did not significantly modify any other variable's OR. Utilizing the reduced regression model we found – among all veterans – females were 1.9 (adjusted Odds Ration – aOR) times ($p=0.052$) more likely to misuse prescription opioids than males (95% CI [1.00, 3.64]) while those living in non-metro counties were 0.368 times ($p=0.210$) less likely to misuse than those living in an urban county (95% CI [0.157, 0.860]). Additional risk factors associated with prescription opioid misuse include treatment or counseling for drug or alcohol use within the past year (aOR=3.64, 95% CI [1.51, 8.80]), participating in risky behaviors (aOR=2.02, 95%

CI [1.28, 3.17]), and drinking alcohol (aOR=2.03, 95% CI [1.03, 3.93]) or heavy alcohol use (aOR=2.94, 95% CI [1.45, 5.93]) compared to those who do not drink. While elevated, binge drinking (p=0.071) was not significantly associated with opioid misuse compared to those who do not drink (aOR=1.83, 95% CI [0.95, 3.53]. Finally, those who experienced psychological distress within the previous year were 2.21 times as likely to misuse prescription opioids (95% CI [1.33, 3.69]).

Among veterans who served before 9/11 the risk factors significantly associated with misusing prescription opioids consisted of those who conducted subjectively risky behavior sometimes or always (aOR=2.45, 95% CI [1.38, 4.34]), received drug or alcohol treatment or counseling within the previous year (aOR=4.97, 95% CI [1.38, 17.9]), and engaged in heavy drinking (aOR=3.25, 95% CI [1.42, 7.44]). Those who identified as a race or ethnicity other than white, Black, or Hispanic were at a reduced risk of misusing prescription opioids compared to those mentioned, and while not significant (p=0.083) those of Hispanic ethnicity were also at reduced prevalence (aOR=0.30, 95% CI [0.08, 1.17]) compared to non-Hispanic white veterans. While not associated (p=0.070), those who drank any alcohol within the past month were 2.22 times as likely to misuse prescription opioids as those who did not drink (95% CI [0.94, 5.26]). Finally, those who experienced psychological distress within the previous year (p=0.064) had increased prevalence of misusing prescription opioids (aOR=2.16, 95% CI [0.96, 4.87]).

Among post-9/11 veterans, those who lived in non-metro areas had lower prevalence of opioid misuse (aOR=0.15, 95% CI [0.05, 0.40]) and while not statistically significant (p=0.066), those who live in small metro areas 0.58 times as likely (95% CI [0.32, 1.04]) to misuse prescription opioids. Risk factors associated with misusing

prescription opioids are those who lived in poverty (aOR=2.53, 95% CI [1.14, 5.62]) and those who experienced psychological distress within the previous year (aOR=2.41, 95% CI [1.29, 4.49]). While not statistically significant females (p=0.081) were at an increased prevalence of opioid misuse (aOR=1.86, 95% CI [0.93, 3.72]) as well as those who have received treatment or counseling for the use of alcohol or any drug (p=0.083) within the previous year (aOR=2.57, 95% CI [0.88, 7.52]).

Discussion

Principal Findings

This study found significant differences in risk factors associated with non-medical opioid use (NMOU) in United States military veterans who served before and after September 11, 2001 (9/11). Veterans serving post-9/11 were more likely to misuse prescription opioids than their pre-9/11 counterparts. This finding supports current literature which demonstrates that younger adults, who would have served during the more recent conflicts, are more at risk of developing NMOU practices (13, 14, 40).

Significant differences were found in the types of risk factors between veterans from each service era. When stratified, veterans who served pre-9/11 who had received treatment or counseling for drug or alcohol use within the previous year and who reported binge drinking within the previous month had a higher prevalence of opioid misuse. Evidence has shown previous alcohol or substance use disorders are associated with an increased risk of opioid misuse (41). Pre-9/11 veterans who reported engaging in risky and thrill-seeking behaviors also had higher prevalence of opioid misuse (11).

Pre-9/11 veterans who identified as a race other than non-Hispanic white non-Hispanic Black, or Hispanic experience a decreased prevalence in NMOU. This is

consistent with the literature (42) that people of color have a reduced prevalence of NMOU compared to non-Hispanic white people. However, this finding needs further exploration as there was a relatively small "other" race sample. Pre-9/11 veterans also had a slightly increased prevalence of NMOU when reporting psychological distress within the previous year. This finding agrees with Chan et al. (15) who found lower psychological distress prevalence among older adults but a stronger association between NMOU and elevated psychological distress scores. This study did not find a significant association likely due to small sample size.

Prescription opioid misuse was more prevalent among United States military veterans who actively served after September 11, 2001, after controlling for all other variables. This finding aligns with current literature as the average age of those who served post-9/11 is younger than those who served prior (11, 43, 44). Post-9/11 veterans who live in urban counties were at greater risk of NMOU compared to those who live in non-metro and small metro counties. Literature has been supportive of higher NMOU in rural and urban populations nationally representative studies have shown equal rates among the populations or higher rates leaning toward urban population (29, 30), while more localized (e.g., statewide) studies typically find urban dwellers have higher rates (27, 28). Post-9/11 veterans who live below the poverty line had a higher prevalence of NMOU compared to those who live above it. The poverty rate for veteran households is 6.6% compared to 13% for non-veteran households, however, the growth rate of those living in poverty is expanding more quickly among the veteran population compared to the non-veterans – 50% increase and 3% increase, respectively (36). In a 2016 study

Ghertner and Groves found higher rates of high opioid prescribing, misuse, hospitalizations, and deaths in counties with worse economic prospects (31).

The only significant common variable between the two groups of veterans was experiencing psychological distress within the previous year. This finding illustrates the importance of monitoring the mental health of all veterans. A validity study of the Kessler K6 non-specific distress scale by Prochaska et al. (33), however, did find the cutoff score of 13 for severe mental illness discounted mild mental illness that was also associated with an increase in substance abuse.

This study produced a novel result as we found an approximate two-fold higher prevalence of opioid misuse among female veterans who served post-9/11. Although this finding was not statistically significant, the effect size merits further exploration. Men are widely reported at greater frequency of NMOU than women in the general population (34, 35), however, extraneous factors suggest a more conducive environment for misuse. For example, women more frequently obtain their first opioids via prescription (34). Also, women are more likely to experience chronic pain (19), and to be prescribed opioid medications at higher doses for longer periods of time (18, 19). These factors combined suggest over-prescription of opioids to female United States veterans might lead to excess misuse compared to males.

Strengths and Limitations

This study has three main strengths. First, it combines data for the three years leading into the COVID pandemic. This allows for better prediction post-pandemic as well as for trend comparison pre- and post-pandemic. Second, this study differentiates between those who served pre- and post-September 11, 2001. Veterans from each of these eras

experienced unique styles of warfare in different environments resulting in varying physical, mental, and emotional stressors. Categorizing veterans in this manner allows for greater generalization to the veteran population. Third, the NSDUH is a nationally representative survey that corresponds to current veteran demographics to include race and gender (36), allowing for better generalization to the veteran population.

There are also several limitations to this study that must be considered. First, for a national sample compiled over three years, there was a relatively small sample size when reduced to United States veterans who had been activated during their service period resulting in few observed cases. This resulted in combining groups into larger and more generalized categories restricting more specific investigations into risk factors. This limitation was further manifested by supporting data not being publicly available and largely being pre-sorted into two or more categories. Second, this study excludes many veterans: active duty military personnel, those institutionalized in group quarters (e.g., hospitals, prisons, nursing homes, and treatment centers), and those who are experiencing homelessness who also do not utilize shelters – the latter two represent a greater portion of the at-risk veteran population.

Third, this study relies upon self-reported data. While much of the data was collected using ACASI, some were collected by interviewers and can contribute to response bias altering the results of the study. Fourth, the NSDUH survey utilized only collected a few military specific data points. While being able to differentiate demographic and lifestyle factors is beneficial, service related data would enhance the results (e.g., PTSD diagnosis, service-connected injury, deployments without exposure to combat, etc.). Fifth, there are integral data points missing from this data set that

would improve the analysis. For example, post-traumatic stress disorder (PTSD) and physical injury from service-related incidents should be considered. Finally, much of the data supporting this study is not publicly available. Lack of access to the entirety of the dataset limited the specificity of what could be explored as much of the data was categorized into two or more larger groups.

Implications for PH Practice

To date, there is limited evidence for risk factors for prescription opioid misuse among veterans, and this is the first study to distinguish between pre- and post-9/11 service members. This study provides important insights into various considerations when prescribing opioids between United States military veterans who have served before and after September 11, 2001. While much of the acceleration of the current opioid epidemic is attributed to synthetic variations (45) it is imperative to continue monitoring prescription opioid use as it is a precursor to misuse. Additionally, the CDC is currently proposing changes to their 2016 opioid prescribing guidelines (37, 38). It is currently unclear as to whether the Department of Defense (DoD) or Veteran's Affairs (VA) will update their policies to align with new CDC guidelines. Regardless, prescribers should consider any veteran's service period and associated risk factors when prescribing.

Considerations for future research

This study posed several unanswered questions that are imperative to investigate to better understand the generational differences in NMOU risk mitigation. Specifically, this study found significant risk factors in demographic and lifestyle behaviors, but future research needs to be conducted to examine military specific risk factors for better detection. Primarily, opioids are prescribed due to pain and veterans experience

significantly higher prevalence of chronic pain than their civilian counterparts (39). This extends to mental health assessment tools as veterans are inherently subjected to a greater amount of potentially traumatizing experiences. The Kessler K6 scale should be considered as a continuous variable to include mild mental illness, or a more in-depth mental illness assessment tool should be utilized to assess mental health more accurately. Further, research should focus on expanding the case size to include more females and racial diversity. Finally, future research should focus on trends in NMOU prevalence and risk factor changes following the COVID pandemic. Using the present study to compare with post-pandemic analyses may assist in identifying trends in the veteran community to better identify and mitigate their risk exposure. This will better allow for the use of non-medication therapies as treatment options.

Conclusion

This study found significant differences in non-medical opioid use risk factors among veterans who served before and after September 11, 2001. Pre-9/11 veterans who reported binge drinking habits and receiving treatment or counseling for drug or alcohol use within the previous year had higher prevalence of opioid misuse. These same veterans had reduced prevalence if they identified as a race other than Hispanic, non-Hispanic white, or non-Hispanic black. Post-9/11 veterans were found to have higher prevalence of NMOU if they live in urban counties or live below the federal poverty line. The only common risk factor among the two groups of veterans is they are at increased risk of NMOU if they reported increased psychological distress in the previous year. While the female gender association disappeared from the overall sample after being stratified by service era, it was a statistically significant risk factor when analyzed

univariately. These risks should be taken into consideration by the Department of Defense if prescribing guidelines are to be changed to align with impending CDC opioid prescription guidance changes.

More research is necessary to elucidate the mechanisms leading to an increased risk among female veterans overall. This study was conducted to account for the initial change in DoD prescribing guidelines in 2017 and a change in use patterns associated with the COVID-19 pandemic. These factors limited this study in sample and effect sizes and led to large confidence intervals prompting the need for further research in these and other veteran-specific risk factors. Continuous research is necessary to recognize current trends in veteran's opioid use patterns and identify those who require early intervention or alternative treatment modalities for pain. Additionally, all veterans should be considered in future research including those who are institutionalized or who are homeless or are housed in shelters to allow for a greater detection rate and to better ascertain risk factors for veterans living in different environments.

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