

Substance use disorders and the risk of suicide mortality among men and women in the US Veterans Health Administration

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ABSTRACT

Background and Aims Limited information is available regarding links between specific substance use disorders (SUDs) and suicide mortality; however, the preliminary evidence that is available suggests that suicide risk associated with SUDs may differ for men and women. This study aimed to estimate associations between SUDs and suicide for men and women receiving Veterans Health Administration (VHA) care. **Design** A cohort study using national administrative health records. **Setting** National VHA system, USA. **Participants** All VHA users in fiscal year (FY) 2005 who were alive at the beginning of FY 2006 ($n = 4\,863\,086$). **Measurements** The primary outcome of suicide mortality was assessed via FY 2006–2011 National Death Index (NDI) records. Current SUD diagnoses were the primary predictors of interest, and were assessed via FY 2004–2005 VHA National Patient Care Database (NPCD) records. **Findings** In unadjusted analyses, a diagnosis of any current SUD and the specific current diagnoses of alcohol, cocaine, cannabis, opioid, amphetamine and sedative use disorders were all associated significantly with increased risk of suicide for both males and females [hazard ratios (HRs)] ranging from 1.35 for cocaine use disorder to 4.74 for sedative use disorder for men, and 3.89 for cannabis use disorder to 11.36 for sedative use disorder for women]. Further, the HR estimates for the relations between any SUD, alcohol, cocaine and opioid use disorders and suicide were significantly stronger for women than men ($P < 0.05$). After adjustment for other factors, most notably comorbid psychiatric diagnoses, associations linking SUDs with suicide were attenuated markedly and the greater suicide risk among females was observed for only any SUD and opioid use disorder ($P < 0.05$). **Conclusions** Current substance use disorders (SUDs) signal increased suicide risk, especially among women, and may be important markers to consider including in suicide risk assessment strategies. None the less, other co-occurring psychiatric disorders may partially explain associations between SUDs and suicide, as well as the observed excess suicide risk associated with SUDs among women.

Keywords Alcohol use disorder, cohort, drug use disorders, substance use disorders, suicide, Veterans Health Administration.

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Submitted 22 February 2016; initial review completed 8 June 2016; final version accepted 27 January 2017

INTRODUCTION

Suicide is a significant global public health concern, responsible for an estimated 1 million deaths annually [1]. In the United States, suicide is one of the leading causes of death [2]. The US Veterans Health Administration (VHA) is the largest integrated health-care system in the United States, and serves a diverse patient population with elevated suicide risk compared with the general US population [3,4].

Although crude suicide rates are greater for male than female VHA patients, sex-specific, age-adjusted standardized mortality ratios (SMRs) indicate that suicide rates among female VHA patients are particularly high relative to women in the general US population [4,5]. Consequently, understanding and addressing suicide risk, especially among women receiving VHA care, is an important priority.

In previous analyses regarding diagnostic factors associated with suicide among VHA patients, a substance use

disorder (SUD) diagnosis was identified as a salient marker of suicide risk, especially among women [6,7]. For example, a report by Ilgen and colleagues found that having any SUD diagnosis was associated with a 2.47 times greater risk of completed suicide [95% confidence interval (CI) = 2.30–2.64] [6]. Furthermore, an SUD diagnosis was associated with a greater risk of suicide among females than males, with associated hazard ratios (HRs) of 6.62 (95% CI = 4.72–9.29) and 2.27 (95% CI = 2.11–2.45), respectively [6]. None the less, it is currently unknown whether the observed sex difference in suicide risk is uniform across all types of SUDs. In addition, prior analyses have not adjusted for important potential confounding factors, in particular co-occurring psychiatric conditions, which are more common among individuals with SUD [8,9]. To inform VHA suicide risk assessment strategies and suicide prevention activities, a greater understanding of the sex-specific associations between SUDs and suicide is needed.

Prior research from other settings has also documented associations between SUDs and increased risk of suicidal behaviors [10–12]. Such studies have investigated predominantly non-fatal suicide outcomes; namely, suicidal ideation, plans and attempts. Relatively few have focused on the specific outcome of suicide death. Among the studies that have examined suicide mortality, the majority have assessed links between alcohol use disorder and suicide, with a smaller number of studies exploring the potential role of other SUDs [13]. Notably, the suicide risk associated with other common SUDs, including cannabis use disorder and cocaine use disorder, remains largely unknown. Furthermore, the minimal information regarding the suicide risk associated with particular SUDs comes from studies estimating individual associations between one type of substance and suicide (e.g. only assessing the risk of suicide associated with opioid use disorder). This lack of data on the suicide risk for more than one type of SUD from the same data source greatly diminishes the ability to evaluate the extent to which risk varies across different types of SUDs, due to differences in populations, study designs and measures between studies. Preliminary evidence from other settings also suggests that the suicide risk associated with SUDs may differ between males and females [6,13]. Two prior meta-analyses found that suicide-specific standardized mortality ratios (SMRs) associated with alcohol use disorder were larger for females than males [13,14]. However, there was an insufficient number of studies to estimate similar sex-stratified SMRs for other SUDs. Consequently, VHA suicide analyses may have broad public health relevance.

In the present investigation, we constructed a cohort that included all VHA users who obtained care in the VHA system within a single fiscal year (FY), and aimed to: (1) estimate the overall and SUD-specific suicide rates among the entire cohort, as well as by sex; (2) estimate

associations between current SUD diagnoses and the risk of suicide in the 6 years of follow-up using a series of sex-stratified proportional hazards models; and (3) calculate, and compare by SUD diagnosis status and sex, percentages of method of suicide among cohort members who died by suicide during follow-up. Analyses were stratified by sex because of the published a priori evidence regarding sex differences in the suicide risk associated with SUD.

METHODS

Design and data

To address the aims of the present study, we conducted a retrospective cohort study in the VHA population using national administrative databases. The study cohort included all VHA users who received services in FY 2005 and were alive at the beginning of FY 2006 ($n = 4\,863\,086$). A FY begins on 1 October of the previous calendar year and ends on 30 September of the calendar year. The cohort was then assessed for suicide from the beginning of FY 2006 through the end of FY 2011 (i.e. a 6-year follow-up).

Data for the cohort were drawn from the VHA National Patient Care Database (NPCD) and the VHA Suicide Data Repository, which includes search results from the Centers for Disease Control and Prevention's National Death Index (NDI). The NPCD is a national VHA patient medical records database that contains demographic, diagnostic and treatment information for all VHA in- and out-patient clinical encounters. Diagnoses in the NPCD are based on clinical judgment, and correspond to the International Classification of Diseases Ninth Revision Clinical Modification (ICD-9-CM). The NDI includes data on the date and cause of death for all deaths that occur within the United States, and classifies causes of death according to the International Classification of Diseases Tenth Revision Clinical Modification (ICD-10-CM). The NDI records are based on death certificates filed to state vital statistics offices. Prior research has shown that the NDI is the most sensitive population-based vital status data source in the United States [15]. The study data set was created using established procedures, and the approach of the present investigation parallels those of previous VHA suicide-related evaluation efforts [4,16,17]. The project was approved by the VA Ann Arbor Institutional Review Board.

Measures

Suicide

The primary study outcome of interest was suicide during the 6 years of follow-up (i.e. FY 2006–2011). Deaths by suicide were identified from NDI data using the ICD-10-CM codes X60–84 and Y87.0. In addition, date of death and method of suicide were obtained from the NDI data.

SUDs

The main predictors of interest were current SUD diagnoses in FY 2004–2005, which were assessed via NPCD records using ICD-9-CM diagnosis codes. Major classes of SUDs included alcohol, cocaine, cannabis, opioid, amphetamine or other psychostimulant, and sedative, hypnotic or anxiolytic use disorders. In addition, a composite indicator of any current SUD was also examined that included any of the aforementioned SUDs, as well as hallucinogen use disorder and/or any other/multiple SUDs. All current SUD diagnoses were based on clinical judgment and recorded by VHA health-care providers (e.g. clinical psychologists) during clinical encounters.

Sex

The stratification variable of male or female sex was ascertained via NPCD demographic records.

Covariates

Several other variables that might confound the relation between SUD and the risk of suicide were included as covariates in the adjusted study analyses. Age in years was ascertained via NPCD demographic records, and was divided into the following categories: 18–29, 30–39, 40–49, 50–59, 60–69, 70–79 or 80 years or older. Similar to other studies using these data, reliable information on other demographic variables (e.g. race/ethnicity, marital status and employment) was not available, and was consequently not included in analyses (e.g. [6]). The Charlson Comorbidity Index is an established metric that was used to assess current non-psychiatric medical comorbidity, including heart disease and cancers, and is based on ICD-9-CM clinical diagnostic codes obtained from FY 2004–2005 NPCD records [18]. Charlson Comorbidity Index scores were recoded into the following categories: 0, 1 or 2 or greater. Current psychiatric diagnoses, which have been shown previously to be associated with suicide risk, were assessed via FY 2004–2005 NPCD diagnostic records. These included the presence or absence of each of the following: depression, schizophrenia, bipolar disorder, post-traumatic stress disorder and other anxiety disorders.

Statistical analysis

Analyses were conducted on the cohort of 4 863 086 individuals who had VHA encounters in FY 2005 and were alive at the beginning of FY 2006. To begin, we calculated the number and percentage of current SUD diagnoses for the entire cohort, as well as by sex. Next, we estimated the overall and SUD-specific suicide rates per 100 000 person-years for the cohort, and separately for males and females. A series of sex-stratified Cox proportional hazards regression models was then used to estimate associations

between each category of SUD, as well as the composite indicator of any SUD and the risk of suicide, with analyses yielding HRs and corresponding 95% confidence intervals (CIs) as the estimates of association [19]. Risk time for all cohort members began on the first day of FY 2006 and ended on their recorded date of suicide or the last day of FY 2011, if alive. Cohort members who died from other causes during the follow-up interval were censored at the recorded date of their death. In addition, all proportional hazards models used covariance sandwich estimators to take into account the clustered nature of the data, with patients nested within VHA facilities. The first model in the series estimated the unadjusted, bivariate relationship between the given SUD category and risk of suicide mortality. The second model adjusted for age group and Charlson Comorbidity. The third model expanded upon the two previous models, with additional adjustment for each of the following co-occurring psychiatric conditions: depression, schizophrenia, bipolar disorder, post-traumatic stress disorder and other anxiety disorders. In additional *post-hoc* analyses, male–female differences in associations between SUDs and suicide were tested using sex by SUD interaction terms in non-stratified hazards models (i.e. models using the full cohort). As a final analytical step, we calculated percentages of method of suicide among all suicide decedents in the cohort, as well as by current SUD status and sex, and performed χ^2 analyses to test differences between groups. All data analyses were conducted using SAS version 9.3.

RESULTS

Table 1 displays age group and current SUD diagnostic characteristics of the cohort overall, as well as by sex. Consistent with the VHA patient population, a majority of the FY 2005 cohort members were male ($n = 4\,460\,447$; 91.7%); 402 639 (8.3%) were female. Age distributions varied between men and women, with greater percentages of women in younger age groups ($P < 0.001$). SUD diagnoses also varied by sex, with a greater percentage of males than females with at least one SUD diagnosis (males = 8.4%; females = 3.4%; $P < 0.001$). Similarly, with respect to specific SUD diagnoses, greater percentages of males had current alcohol, cocaine, cannabis, opioid, amphetamine and sedative use disorder diagnoses than females.

Table 2 presents suicide information for the entire cohort, as well as stratified by sex. During the 6-year follow-up interval, 9087 cohort members died by suicide; the overall suicide rate was 34.7 per 100 000 person-years. Suicide rates were approximately threefold greater for men than women. The suicide rate among individuals with an SUD diagnosis was 75.6 per 100 000 person-years; 76.1 per 100 000 person-years for males and 63.4

Table 1 Characteristics of the cohort of fiscal year (FY)05 Veterans Health Affairs (VHA) patients alive at the beginning of FY 2006, total and by sex ($n = 4\,863\,086$).

Characteristic	All		Male		Female	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Total	4 863 086	100.0	4 460 447	100.0	402 639	100.0
Age group (years)						
18–29	1 58 967	3.3	1 10 376	2.5	48 591	12.1
30–39	245 266	5.0	182 128	4.1	63 138	15.7
40–49	514 083	10.6	410 439	9.2	103 644	25.7
50–59	1 161 916	23.9	1 057 552	23.7	104 364	25.9
60–69	955 689	19.7	915 564	20.5	40 125	10.0
70–79	1 136 095	23.4	1 118 723	25.1	17 372	4.3
80+	691 070	14.2	665 665	14.9	25 405	6.3
Any SUD	386 238	7.9	372 717	8.4	13 521	3.4
Alcohol use disorder	307 923	6.3	298 831	6.7	9092	2.3
Cocaine use disorder	83 808	1.7	80 565	1.8	3243	0.8
Cannabis use disorder	56 524	1.2	53 968	1.2	2556	0.6
Opioid use disorder	37 908	0.8	36 284	0.8	1624	0.4
Amphetamine or other psychostimulant use disorder	12 033	0.2	11 321	0.3	712	0.2
Sedative, hypnotic or anxiolytic use disorder	7301	0.2	6779	0.2	522	0.1

SUD = substance use disorder.

Table 2 Overall and substance use disorder (SUD)-specific suicide mortality and rates among the Veterans Health Affairs (VHA) patient cohort, total and by sex ($n = 4\,863\,086$).

Characteristic	All suicide mortality			Suicide mortality among males			Suicide mortality among females		
	FY06–11		Suicide rate per 100 000 person-years	FY06–11		Male suicide rate per 100 000 person-years	FY06–11		Female suicide rate per 100 000 person-years
	<i>n</i>	%		<i>n</i>	%		<i>n</i>	%	
Overall	9087	100.0	34.7	8796	100.0	36.9	291	100.0	12.4
Any SUD	1573	17.3	75.6	1524	17.3	76.1	49	16.8	63.4
Alcohol use disorder	1259	13.9	76.2	1231	14.0	76.9	28	9.6	54.0
Cocaine use disorder	231	2.5	49.3	222	2.5	49.3	9	3.1	48.0
Cannabis use disorder	246	2.7	77.4	239	2.7	78.9	7	2.4	47.3
Opioid use disorder	177	1.9	86.9	168	1.9	86.4	9	3.1	98.6
Amphetamine or other psychostimulant use disorder	64	0.7	95.0	61	0.7	96.5	3	1.0	72.4
Sedative, hypnotic or anxiolytic use disorder	66	0.7	171.4	62	0.7	174.1	4	1.4	138.7

FY = fiscal year.

per 100 000 person-years for females. With respect to specific SUDs, the suicide rate associated with sedative use disorder was largest, followed by amphetamine, opioid, cannabis, alcohol and cocaine use disorders. Specific SUD-associated suicide rates followed the same pattern for men. Among women the order differed, with the highest suicide rate observed for sedative use disorder followed by opioid, amphetamine, alcohol, cocaine and cannabis use disorders.

Results from the sex-stratified proportional hazards regression models estimating prospective associations

between current SUDs and the risk of suicide during the follow-up interval are displayed in Table 3. In the unadjusted models (model 1) all current SUDs, as well as any current SUD, were associated significantly with increased risk of suicide among both men and women; however, the strength of the association was approximately two- to threefold greater for women than men. In *post-hoc* tests, substance-specific estimates for alcohol, cocaine and opioid use disorders, as well as the estimate for any SUD, were significantly greater for women than men ($P < 0.05$). After adjustment for age group and Charlson Comorbidity

Table 3 Cox hazards models estimating associations between current substance use disorder (SUD) and suicide mortality during the follow-up interval, fiscal year (FY) 06–11 (*n* = 4 863 086).

Characteristic	Model 1 ^a						Model 2 ^b						Model 3 ^c					
	Males			Females			Males			Females			Males			Females		
	HR	95% CI	P	HR	95% CI	P	HR	95% CI	P	HR	95% CI	P	HR	95% CI	P	HR	95% CI	P
Any SUD	2.29	2.12, 2.46	< 0.001	5.95	4.29, 8.26	< 0.001	2.26	2.11, 2.43	< 0.001	4.82	3.42, 6.79	< 0.001	1.67	1.55, 1.79	< 0.001	2.15	1.44, 3.21	0.001
Alcohol use disorder	2.26	2.10, 2.44	< 0.001	4.72	3.15, 7.06	< 0.001	2.21	2.06, 2.38	< 0.001	3.73	2.48, 5.62	< 0.001	1.64	1.52, 1.76	< 0.001	1.57	1.01, 2.45	0.047
Cocaine use disorder	1.35	1.17, 1.55	< 0.001	3.97	2.13, 7.39	< 0.001	1.19	1.03, 1.36	0.014	2.88	1.50, 5.50	0.001	0.74	0.64, 0.84	< 0.001	1.10	0.57, 2.15	0.776
Cannabis use disorder	2.17	1.91, 2.48	< 0.001	3.89	1.80, 8.37	0.001	1.97	1.72, 2.25	< 0.001	2.90	1.34, 6.25	0.007	1.16	1.02, 1.33	0.024	1.01	0.45, 2.26	0.990
Opioid use disorder	2.37	1.96, 2.86	< 0.001	8.19	3.74, 17.95	< 0.001	2.12	1.76, 2.56	< 0.001	5.90	2.66, 13.10	< 0.001	1.31	1.08, 1.58	0.005	2.33	1.05, 5.18	0.038
Amphetamine or other psychostimulant use disorder	2.63	2.06, 3.35	< 0.001	5.90	2.10, 16.57	< 0.001	2.32	1.82, 2.95	< 0.001	4.42	1.52, 12.91	0.006	1.30	1.02, 1.64	0.032	1.50	0.52, 4.38	0.456
Sedative, hypnotic or anxiolytic use disorder	4.74	3.64, 6.17	< 0.001	11.36	3.67, 35.14	< 0.001	4.26	3.27, 5.56	< 0.001	8.28	2.69, 25.53	< 0.001	1.97	1.51, 2.57	< 0.001	2.41	0.79, 7.44	0.127

^aUnadjusted. Covariance sandwich estimators were used to adjust for clustering within Veterans Health Affairs (VHA) facilities. ^bControlling for age and Charlson Comorbidity Index. Covariance sandwich estimators were used to adjust for clustering within VHA facilities. ^cControlling for age, Charlson Comorbidity Index and psychiatric diagnoses. Covariance sandwich estimators were used to adjust for clustering within VHA facilities. HR = hazard ratio; CI = confidence interval.

(model 2), the HR estimates associated with SUDs were attenuated marginally for men and more moderately for women, yet all remained statistically significant. Furthermore, although the same substance-specific HR estimates remained significantly greater for women than men in *post-hoc* tests ($P < 0.05$), the magnitude of the difference was not as pronounced as in model 1. In the third set of regressions, additional adjustment was made for current co-occurring psychiatric diagnoses (model 3), which further attenuated the SUD HRs. For men, cocaine use disorder became associated inversely with suicide, and for women significant associations remained only for alcohol and opioid use disorders, as well as any SUD. In addition, *post-hoc* analyses revealed that male–female differences were no longer significant for alcohol use disorder in model 3.

Figure 1 displays method of suicide among all individuals in the cohort who died by suicide during the follow-up interval, as well as by current SUD status and sex. Overall, firearm use was the most common method of suicide. Firearm use was more common among decedents without a current SUD diagnosis at baseline than among those with a current SUD diagnosis. It was also more common among males than females. Poisoning was more common among decedents with a current SUD than those without one, as well as more common among women than men.

DISCUSSION

In this investigation, we estimated associations between current SUDs and risk of suicide in more than 4.8 million men and women who used VHA services in FY 2005. In unadjusted analyses, a current diagnosis of any SUD and

the specific current diagnoses of alcohol, cocaine, cannabis, opioid, amphetamine or other psychostimulant, and sedative hypnotic or anxiolytic use disorders were all associated with elevated risk of suicide for both males and females. Further, the relative risk estimates for the relations between any SUD, alcohol, cocaine and opioid use disorders and suicide were markedly stronger for women than men. However, after adjustment for other factors, most notably comorbid psychiatric diagnoses, associations linking current SUDs with suicide were attenuated and male–female differences observed in the unadjusted models were diminished.

Although links between SUDs and non-fatal suicide outcomes have been reported in the literature, only a limited number of prior studies have examined suicide mortality. The few studies investigating suicide mortality have noted individual associations between any SUD, alcohol use disorder and opioid use disorder and suicide [13]. The present investigation is one of the first to provide estimates of the suicide risk associated with current cannabis, cocaine, amphetamine and sedative use disorders in a broad population cohort. Furthermore, to the best of our knowledge, prior work has not examined links concurrently between specific SUDs and suicide mortality within the same data source. Consequently, previous studies have not allowed for comparisons in the magnitude of risk associated with specific types of SUDs. Nor have these comparisons been made separately for men and women, despite evidence of sex-differences in the risk factors for suicide and the need for greater understanding of SUD and suicide among women [13,20–22]. Findings from the present investigation indicate that associations between SUDs and risk of suicide vary by sex as well as type of SUD. Among

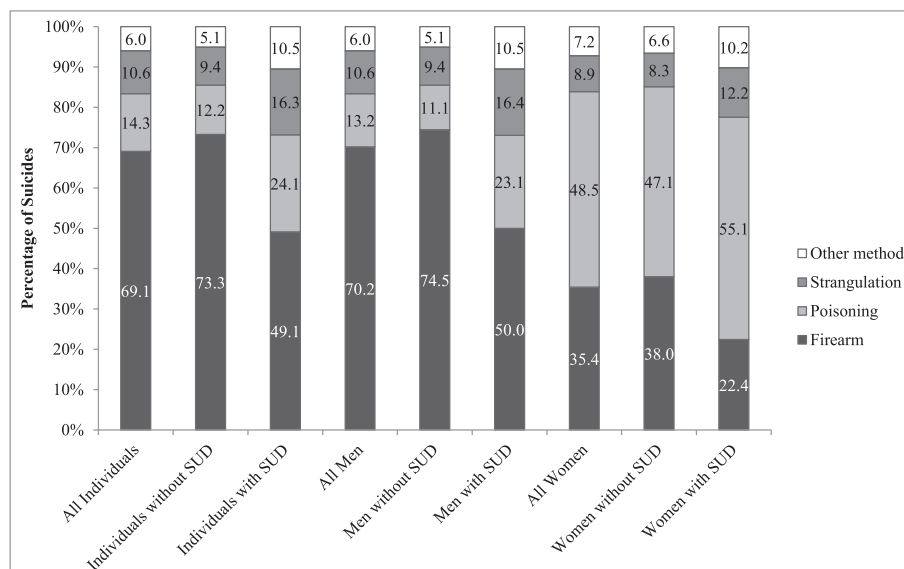


Figure 1 Method of suicide among all suicide decedents and by current substance use disorder (SUD) diagnosis status and sex, fiscal year (FY) 06–11 ($n = 9087$)

men, the unadjusted suicide HRs ranged from 1.35 for cocaine use disorder to 4.74 for sedative use disorder. Among women, there was greater variation in the suicide risk estimates by type of SUD, with HRs ranging from 3.89 for cannabis use disorder to 11.36 for sedative use disorder. Such differences may be important for clinicians and health systems to consider when providing care for patients with SUDs, and could help to inform suicide prevention efforts. The sizable risk of suicide among women with a current opioid use disorder is especially noteworthy, and may be important for clinicians to be aware of when treating such patients.

The marked differences between males and females in the crude SUD–suicide associations, as well as the variability in suicide risk between specific types of SUDs, were attenuated appreciably after adjustment for co-occurring psychiatric diagnoses. For instance, the HR for suicide associated with a current alcohol use disorder was reduced from 2.26 to 1.64 for men and from 4.72 to 1.57 for women after adjustment. In the case of cocaine use disorder among males, the direction of the association was reversed after including other psychiatric diagnoses, such that cocaine use disorder was associated with a 26% reduction in suicide risk. Among women, HRs associated with cocaine and cannabis use disorders approached the null and were non-significant after the inclusion of comorbid psychiatric diagnoses. Previous work has found that co-occurring psychopathology may be especially salient among those with a cocaine use disorder who attempt suicide [23,24], and our finding of an inverse association among men might be due in part to collinearity between cocaine use disorder and other psychiatric conditions; however, further research is needed to better understand suicide mortality among those with a cocaine use disorder. In general, few prior longitudinal studies examining links between SUDs and suicide mortality have taken into account comorbid psychiatric conditions, due possibly to additional sample size requirements beyond those that are already necessary to study the rare event of suicide. However, the previous investigations that have included adjustment for other covariates have also noted that underlying psychiatric comorbidity may partially explain associations between SUDs and suicide [25]. Collectively, these findings highlight the potentially confounding role of comorbid psychiatric illness in SUD–suicide associations. Hence, assessment and treatment of comorbid psychiatric conditions may be important in lowering the risk of suicide among individuals with co-occurring SUDs and other psychopathology. None the less, findings from the present investigation suggest that even after statistical adjustment for comorbid psychiatric conditions SUDs (in particular, alcohol and opioid use disorders) may confer excess risk for suicide mortality independently. Therefore, SUD treatment, including integrated or additional SUD-specific

treatment for those with co-occurring psychiatric conditions, with assessment and management of suicidal behaviors may be important for suicide prevention. In addition, the findings from the present study regarding method of suicide among decedents with SUD highlight the importance of developing strategies to prevent intentional poisoning, as well as including firearm safety in suicide prevention efforts, for individuals with SUDs.

Theoretical models regarding suicide risk among individuals with SUDs posit that proximal risk for suicide is driven by ongoing substance use, psychiatric symptoms and interpersonal stress [11]. In the present study, the presence of a clinical diagnosis of a co-occurring psychiatric condition probably reflects a combination of symptoms and distress/impairment. Unfortunately, no data are available on the extent of substance use in the present cohort. However, in the absence of such data, it is possible that much of the risk is carried by this clinically significant symptom impairment. Ideally, future work would be able to model fluctuations in psychiatric symptoms and substance use that might drive suicidal behaviors in those with SUDs, as well as the extent to which these fluctuations can be modified by treatment.

There are several limitations that should be considered when interpreting findings from the present investigation. First, the study cohort included all patients who used VHA services in a given year. Previous research has found that individuals who use VHA services may have poorer physical and mental health functioning, as well as higher rates of suicide, than those in the US general population [4,26,27]. Web-based analyses of national injury data from the US Centers for Disease Control and Prevention's (CDC's) Web-based Injury Statistics Query and Reporting System (WISQARs) show that the crude suicide rate was 15.56 per 100 000 person-years for adults aged 20 years and older, and 25.33 per 100 000 person-years for males and 6.39 per 100 000 person-years for females, during the same time-period as study follow-up (i.e. 2006–11) [28]. These crude rates for the US population are lower than those found among our VHA cohort. Consequently, findings may not be generalizable to patient populations from other health settings. Secondly, although death data are from the NDI, which is the 'gold standard' for ascertainment of mortality in the United States [15], cause of death may still be subject to misclassification. In particular, distinguishing between suicide and accidental overdose may be problematic among individuals with SUDs, especially among those with opioid use disorders (e.g. [29]). Thirdly, current SUD and other psychiatric diagnoses were obtained from administrative records in the NPCD. Diagnoses are based on VHA providers' clinical assessment and judgment. As such, the validity and reliability of these current diagnoses are unknown. Fourthly, administrative data used in study analyses do not contain information

on level of severity of SUDs, which may be important to consider in future studies. It is also possible that the level of severity of SUDs that were diagnosed by providers may have differed between men and women. Such differences could have had an impact on the observed associations between SUDs and suicide. Fifthly, analyses were limited to the investigation of suicide risk associated with current SUD diagnoses; specific information regarding the extent of drug use including polydrug use is also unavailable in VHA administrative data. None the less, research regarding levels of drug use and polydrug use is an important area of suicide research that requires further study [12]. Sixthly, given the observational, non-randomized nature of the study design, incomplete adjustment for confounding factors, measured or unmeasured, is a potential limitation. Such factors may include unreliable or unmeasured demographic variables that were omitted from study analyses. We were also unable to account for comorbid SUD diagnoses in analyses due to power concerns, especially among women. Therefore, findings should be interpreted within the context of this limitation, and additional research is required regarding the potential role of co-occurring SUDs on suicide. Finally, study analyses compared individuals with current SUD diagnoses to those without current SUD diagnoses. We were unable to categorize further those without current SUD diagnoses into former SUD and never SUD groups. Further research is needed to examine the potential impact of remitted SUDs on suicide risk.

Despite these limitations, this investigation provides novel and important data regarding current SUDs and the risk of suicide. SUDs may be important markers of suicide risk, especially among women, and may be important factors for health systems and clinicians to consider including in suicide risk assessment strategies. Nevertheless, other co-occurring psychiatric disorders may partially explain associations between SUDs and suicide, as well as the observed excess suicide risk associated with SUDs among women.

Declaration of interests

None.

Acknowledgements

This work was supported by the Department of Veterans Affairs (VA) Office of Mental Health Services and the VA Office of Mental Health Operations. Data were acquired for program planning and evaluation purposes—not for research. Input from senior mental health leadership at the VHA Central Office helped shape the design and conduct of the study; the collection, management, analysis and interpretation of the data and the preparation, review and approval of the manuscript. In addition, K.M.B. is

supported by a VA Health Services Research and Development Career Development Award (CDA 11-245). The views expressed in this report are those of the authors and do not necessarily represent those of the VA.

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