ORIGINAL RESEARCH

Suicidal Behaviors Among Active-Duty US Service Members: Data from the 2018 Health-Related Behaviors Survey

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Background: This study aimed to 1) determine the prevalence of past-year suicidal ideation (SI) and attempts (SA) among active-duty SMs; 2) determine whether differences exist by age, sex, and race; and 3) assess whether prevalence estimates vary by risk profiles of mental health conditions and substance use.

Methods: Data were from the 2018 Health-Related Behavior Survey (HRBS), a cross-sectional survey of active-duty SMs (n = 17,166). We used the logistic model to identify the factors of SI and SA and latent class analysis (LCA) to identify the risk profiles.

Results: Among active duty SMs, 8.26% had SI and 1.25% had SA in the past year. Gender and age have been shown to influence how race might contribute to suicidal behaviors. Mental health conditions were associated with higher odds of SI and SA, as were younger ages; LGB identity; being separated, divorced, or widowed; use of e-cigarettes, dual use of e-cigarettes and cigarettes, or drugs; and history of deployment of less than 12 months. Frequencies of cigarette and e-cigarette use were also associated with SI and SA, indicating the odds were increasing by 0.3% for every additional cigarette or e-cigarette used. Five risk profiles were identified: class 1 (illegal drug use), class 2 (mental health needs with tobacco and alcohol use), class 3 (mental health conditions only), class 4 ("low risk" SMs with low levels of illegal drug use, mental health visits, tobacco use, and alcohol use), and class 5 (alcohol use). Compared to class 4 ("low risk"), all other risk profiles were associated with increased odds of suicidal behaviors.

Conclusion: Despite the resources and increased access provided for mental health support, the prevalence of SI among active-duty SMs is greater than in the general population of the same age, likely due to additional military exposures and stressors.

Keywords: suicide, ideation, attempts, mental health, e-cigarette, active-duty service member

Introduction

Suicide was the second-leading cause of death among the 25–34 year old age group and the tenth-leading cause of death for all age groups in the US population between 2000 and 2020.[1] Similarly, from 2006 to 2021, suicide, or self-inflicted death, represented 25.4% of deaths among US military active-duty servicemembers (SMs) and was second only to accidental (unintentional) as a cause of death.[2] Between 2000 and 2012, suicide rates among SMs doubled; since 2012 there have been no appreciable changes in the annual rate of approximately 19.74 deaths per 100,000 service members. The rate of suicide in the civilian population was 14.2 per 100,000 in 2018, decreasing to 13.5 in 2020 and increasing to 14.0 in 2021.[3] While the unadjusted rate among enlisted US military service members (SMs) is significantly higher than the US civilian population estimate,[4] the age- and sex-adjusted military rate may be similar to the US adult population.[5] Service in the military is voluntary and the demographic distribution among the US military is not representative of the US general population,[6] and rates vary by model. Suicides and suicidal behaviors are preventable.[7] Suicidal behaviors such as suicidal ideation (SI), suicide plans (SP), and suicide attempts

(SA) represent key indicators for prevention efforts to reduce suicide-related deaths.[8] Survey studies provide valuable self-reported information on the burden of suicidal behaviors among a population. It is common that survey studies use a single-item assessment of SI, SP, and SA to measure the presence or absence of each behavior during three timeframes (eg, lifetime, past year, and past month). For example, the lifetime prevalence estimates of SA, SP, and SI among military personnel are 2.4%, 5.3%, and 13.9%, respectively.[8] A recent representative survey of Army members during their basic combat training reported similar estimates of SI (13.0%) and SA (1.7%).[9] In contrast, a one-year study in the Air Force reported a lower prevalence of suicidal ideation of 3% among males and 5.5% among females, and 8.7% of the ideators reported SA.[10] Suicidal behaviors during deployment have been of particular concern, although the estimates of medically documented SA among deployed SMs was low (0.4%).[11] This indicates that estimates from medically documented records or administrative data might be lower than those obtained from surveys. We proposed this study to estimate the prevalence of suicidal behaviors using a survey because it represents an appropriate source for this estimation. In addition, most of the studies that assessed risk factors of suicidal behaviors among SMs were based on medically documented records or administrative data.[12–15] In this vulnerable population, suicidal behaviors have been associated with demographic variables including young age,[12] female gender,[12–14] white race,[14–16] marital status,[10] high-school education or less,[13,14] the first four years in service,[13] and enlisted ranks.[10] These studies have shown inconsistent findings as suicide remains to be a serious problem among non-White males in middle age and later life.[17] This conflicting evidence warrants further investigation using an intersectional approach, as the contribution of race might depend on gender or age groups. To our knowledge, there has been no research assessing such associations in active-duty SMs. We aimed to address this gap to improve risk stratification of suicidal behaviors in clinical settings, particularly in the general medical practice and specialty clinics. Finally, studies among active-duty SMs have documented the association between suicidal behaviors and mental health conditions, including anxiety,[16] depression,[18] posttraumatic stress disorder,[18] and having received a mental health diagnosis.[18] These factors represent traditional risk factors for suicidal behaviors in the military and non-military populations.[18,19] In this study, we 1) explored data-driven mental health conditions and substance use profiles in SMs, and 2) evaluated hypothesized relationships by assessing how different risk profiles correlate with suicidal behaviors. The Department of Defense (DoD) *Survey of Health-Related Behaviors* (HRBS) has been an important source of health behavior information for the military by surveying both active-duty and reserve components periodically since 1980.[6,20] Research on suicidal behaviors is lacking in HRBS respondents. This study utilizes data from the 2018 HRBS of active-duty service members to 1) estimate the prevalence of Suicidal behaviors (SI and SA) among active-duty SMs; 2) determine whether differences exist by age, sex, and race; and 3) assess whether prevalence estimates vary by risk profiles of mental health conditions and substance use. We hypothesized that the latent class analysis would identify distinct groups of illegal drug users and mental health needs and that these groups would increase the odds of suicidal behaviors. We also hypothesized that sex and age might modify race differences in reporting suicidal behaviors.

Methods
Sample
Data were utilized from the 2018 DoD Health-Related Behavior Survey (HRBS). The sample analyzed consists of 17,166 active-duty SMs from the Army, Navy, Air Force, Marine Corps, and Coast Guard service branches. The 2018 HRBS's response rate was 9.6%.[20] The Institutional Review Board of the Uniformed Services University of the Health Sciences approved the study.

Measures
Suicidal Behavior Assessment
The HRBS uses a single-item assessment of past-year SI, SP, and SA to measure the presence or absence of each behavior. Respondents were classified as having SI if they selected "yes" for either of the following questions: At any time in the PAST 12 MONTHS, did you seriously think about trying to kill yourself?" and "During the PAST 12

MONTHS, did you make any plans to kill yourself?" SA were qualified with one question: "During the PAST 12 MONTHS, did you try to kill yourself?" Answer choices were limited to "no" and "yes". We further explored past-year ideators to assess the burden of suicide attempts in this vulnerable group.[10,21,22]

Health Behaviors

We evaluated data on mental health conditions including mental health visits in the last year, perceived unmet mental health needs (yes/no), psychological distress in the past 12 months using the Kessler (K6) Psychological Distress Scale, and posttraumatic stress disorder in the past month as defined by the Primary Care Post Traumatic Stress Disorder (PC-PTSD) Screen for DSM-5. We assessed the reliability and validity of K6 and PC-PTSD-5 subscales among SMs. The reliability and predictive power of K6 and PC-PTSD-5 were determined using Cronbach's alpha and areas under (AUC) the receiver operating characteristic curves. An optimal cutpoint was determined for each subscale using Youden's index. Both subscales were reliable for use in this population; the Cronbach's alpha was 0.90 for K6 and 0.81 for PC-PTSD-5. The validity assessment confirmed that both subscales were valid to assess SA and SI. The predictive ability of SA using K6 and PC-PTSD-5 was 0.83 and 0.69, respectively. The predictive ability of SI using K6 and PC-PTSD-5 was 0.81 and 0.70, respectively. For SA, K6 had an optimal cutpoint of 17.5, and PC-PTSD-5 had 3.5. For SI, K6 had an optimal cutpoint of 12.5, and PC-PTSD-5 had 3.5. We further evaluated the dimensionality of these two subscales using confirmatory factor analysis (CFA). With eigenvalue greater than one, the CFA analysis resulted in a single-factor dimension for K6 (accounting for 66.6%) and PC-PTSD-5 (accounting for 57.0%). The factor loading ranges between 0.73 and 0.89 for K6 and 0.72 to 0.81 for PC-PTSD-5. We assessed data on substances such as heavy alcohol use (yes/no); prescription drug misuse (stimulant, sedative, or pain medications—as measured by yes/no); and tobacco use status over the past 30 days (none, cigarettes only, e-cigarettes only, and dual use of e-cigarettes and cigarettes). Heavy alcohol use was defined as drinking 1–2 days, 3–4 days, 5–6 days, or about every day a week during the past 30 days.[20] We examined the number of cigarettes smoked/day during the past 30 days and the number of e-cigarettes during the past 30 days. Respondents who skipped these two questions were recorded as no use or "0". We also assessed the associations between the length of previous deployment and SI and SA. For latent class analysis (LCA), we evaluated specific substance use (1 = yes, 0 = no), including past 12 month use of: marijuana or hashish; other illegal drugs; cocaine; lysergic acid diethylamide (LSD); ecstasy; prescription stimulants or attention enhancers; prescription sedatives, tranquilizers, muscle relaxers, or barbiturates; prescription pain relievers; mental health visit; unmet mental health needs; cigarette use; e-cigarette use; cigar use; pipe/hookah use; heavy drinkers; binge drinking; any alcohol consequences; risky drinking and driving behaviors; PTSD-5; and K6.

Sociodemographic Variables

Each health behavior was analyzed in the context of sociodemographic characteristics that include the following: sex, race (Non-Hispanic White, Non-Hispanic Black, Hispanic, and Other), age groups (17–24, 25–34, 35–44, and 45 years and above), education (high school or less, some college, bachelor's degree or more), marital status (married, cohabiting, never married, and separated, divorced, widowed), obesity (body mass index $\geq$30 kg/m^2), lesbian, gay, or bisexual (LGB) (yes/no), service branch (Air Force, Army, Marine, Navy, and Coast Guard), and rank (officers or enlisted).

Statistical Analysis

Data analysis was performed using SAS 9.4 (TS1M7) (SAS Institute Inc., Cary, NC, USA). Sampling weights were used in all analyses. Sample characteristics were summarized by an overall weighted percent (%) estimates (Table 1). Weighted prevalence estimates of past-year SI, suicide plans, SA, and SA among SMs reporting SI (Table 2) were summarized by percent (%) and corresponding standard error (SE). The authors treated PC-PTSD-5 and K6 as continuous rather than dichotomous variables in all analysis. To assess intersectionality, we performed stratified analysis of SI and SA by age, sex, and race and ethnic group using the F-test. The crude and adjusted odd ratios of SI and SA were presented by sociodemographic characteristics (Table 3). However, to avoid multicollinearity, each health behavior and mental health condition was then assessed as a separate exposure after adjusting for sociodemographic variables using weighted logistic models (Table 4). The strength of the association was assessed by the odds ratio (OR) and 95%

Table 1 Characteristics of Study Respondents (n = 17,166)

Variable	Category	N	%	SE
Sex	Female	5353	16.69	0.35
	Male	11,813	83.31	0.35
Age	17–24 years	3642	37.77	0.68
	25–34 years	6467	39.93	0.59
	35–44 years	5311	18.33	0.33
	≥ 45 years	1746	3.97	0.13
Education	Missing	250	1.16	0.13
	High School or less	7990	64.41	0.52
	Some College	2625	12.82	0.32
	Bachelor's Degree or more	6301	21.61	0.38
Race	Missing	68	0.71	0.16
	Black	2226	16.18	0.49
	Hispanic	2459	15.99	0.47
	Other	1747	9.48	0.33
	White	10,666	57.63	0.62
Marital Status	Married	10,776	53.83	0.64
	Cohabiting	1042	7.78	0.36
	Separated, Divorced, or Widowed	1284	6.27	0.27
	Never Married	4064	32.12	0.64
Obese	Yes	2467	14.36	0.41
Lesbian, Gay, or Bisexual	Yes	1236	6.34	0.27
Service Branch	AF	5579	24.09	0.40
	ARMY	3646	34.48	0.67
	MC	2569	13.90	0.39
	NAVY	3675	24.36	0.55
	USCG	1697	3.17	0.10
Rank	Enlisted	12,154	83.52	0.32
	Officer	5012	16.48	0.32
Smoke	None	13,842	73.18	0.60
	E-cigarettes	1049	8.45	0.40
	Cigarettes	1496	10.59	0.40
	E-cigarettes and Cigarettes	779	7.78	0.41
Heavy alcohol use	Yes	1336	9.82	0.40

(*Continued*)

Table 1 (Continued).

Variable	Category	N	%	SE
Drug misuse	Yes	180	1.38	0.18
Mental health visits	None	13,381	78.88	0.50
	1–2	1018	5.68	0.30
	3–9	1394	7.56	0.31
	≥ 10	1373	7.88	0.34
Unmet mental health needs	Yes	1114	6.81	0.33
Length of deployment	Not Deployed	5550	39.57	0.64
	1 to 12 months	4060	26.78	0.56
	More than 12 months	7556	33.65	0.52
			Mean	SE
Kessler psychological distress scale (K6)	Range: 0–24		10.93	0.14
Post-traumatic stress disorder (PC-PTSD-5)	Range: 0–5		1.85	0.04

Table 2 Weighted Prevalence Estimates by the Sample Characteristics and Health Behaviors

Category	Past-Year Suicide Ideation (SI)			Past-Year Suicide Plans			Past-Year Suicide Attempts (SA)			SA Among SMs Reporting SI		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
Overall	1069	8.3	0.4	375	2.7	0.2	130	1.2	0.2	120	14.2	1.9
Gender												
Female	394	10.1	0.7	135	3.6	0.4	48	1.7	0.4	46	16.4	3.3
Male	675	7.9	0.4	240	2.6	0.2	82	1.2	0.2	74	13.6	2.2
Age												
17–24 years	350	11.1	0.8	132	4.1	0.5	61	2.5	0.4	58	20.9	3.4
25–34 years	391	7.3	0.5	126	2.0	0.2	35	0.5	0.1	33	6.7	1.4
35–44 years	277	5.6	0.4	98	1.9	0.2	28	0.6	0.1	24	8.7	1.9
≥ 45 years	51	3.1	0.5	19	0.9	0.2	6	0.3	0.1	5	8.2	4.0
Education												
High school or less	645	9.9	0.6	223	3.3	0.3	84	1.6	0.3	79	15.7	2.4
Some college	151	6.5	0.7	48	2.0	0.4	13	0.4	0.1	13	6.0	2.0
College degree	264	4.3	0.3	100	1.6	0.2	31	0.6	0.2	26	12.2	3.1
Race												
Black	148	8.0	1.0	53	2.0	0.4	24	1.5	0.5	23	17.8	5.5

(*Continued*)

Table 2 (Continued).

Category	Past-Year Suicide Ideation (SI)			Past-Year Suicide Plans			Past-Year Suicide Attempts (SA)			SA Among SMs Reporting SI		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
Hispanic	151	7.9	0.9	53	2.9	0.6	19	1.4	0.5	18	18.0	5.6
Other	103	7.6	1.0	33	2.2	0.5	17	0.9	0.2	15	10.1	2.9
White	661	8.3	0.5	235	3.0	0.3	69	1.2	0.2	63	13.3	2.4
Marital status												
Married	520	6.2	0.4	164	1.7	0.2	44	0.6	0.2	39	9.7	2.7
Cohabiting	96	11.5	1.6	35	3.4	0.7	18	2.2	0.7	17	15.4	4.4
Separated, Divorced, or Widowed	133	15.5	2.2	60	5.8	1.3	20	3.1	1.2	19	19.8	6.9
Never Married	320	9.6	0.8	116	3.6	0.5	48	1.7	0.4	45	16.9	3.4
Obese												
Yes	203	10.2	1.0	79	3.5	0.5	25	1.1	0.3	23	10.2	2.9
No	866	7.9	0.4	296	2.6	0.2	105	1.3	0.2	97	15.0	2.2
LGB												
Yes	153	15.8	1.7	60	6.9	1.2	25	3.2	0.8	22	18.8	4.7
No	916	7.7	0.4	315	2.5	0.2	105	1.1	0.2	98	13.5	2.1
Service branch												
Army	240	8.5	0.8	82	2.4	0.4	29	1.4	0.4	28	15.4	4.0
Marine Corps	222	10.1	0.9	91	4.2	0.6	32	1.6	0.4	31	15.4	3.7
Navy	277	10.8	0.9	102	3.7	0.5	37	1.6	0.4	32	13.7	3.3
Coast Guard	72	4.7	0.8	19	1.6	0.6	5	0.2	0.1	5	4.8	2.4
Air Force	258	4.8	0.3	81	1.6	0.2	27	0.6	0.1	24	12.0	2.5
Rank												
Officer	198	3.9	0.3	62	1.2	0.2	19	0.3	0.1	16	7.0	2.0
Enlisted	871	9.1	0.5	313	3.0	0.3	111	1.4	0.2	104	14.8	2.1
Smoke status												
None	707	6.0	0.3	225	1.7	0.2	75	0.7	0.1	66	10.4	1.8
E-cigarettes only	102	13.3	2.0	34	4.3	1.1	15	2.9	1.1	14	21.3	7.4
Cigarettes only	139	11.1	1.3	53	3.5	0.6	15	1.1	0.4	15	9.9	3.3
E-cigarettes and Cigarettes	121	19.9	2.3	63	9.8	1.8	25	4.6	1.4	25	23.3	6.0
Heavy alcohol use												
Yes	177	16.6	1.7	71	7.5	1.2	23	2.2	0.7	22	12.7	4.1
No	892	7.4	0.4	304	2.2	0.2	107	1.1	0.2	98	14.5	2.1

(*Continued*)

Table 2 (Continued).

Category	Past-Year Suicide Ideation (SI)			Past-Year Suicide Plans			Past-Year Suicide Attempts (SA)			SA Among SMs Reporting SI		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
Drug misuse												
Yes	37	28.7	6.3	19	13.8	4.9	10	8.0	4.2	10	27.7	12.8
No	1032	8.0	0.4	356	2.6	0.2	120	1.2	0.2	110	13.5	1.9
Mental health visits												
None	427	4.5	0.3	109	1.1	0.2	35	0.5	0.1	29	8.3	2.0
1 to 2	82	10.5	1.6	24	2.5	0.7	3	0.2	0.2	3	2.4	1.5
3 to 9	193	19.4	1.9	63	6.9	1.4	22	3.9	1.3	19	19.4	5.8
≥ 10	367	34.1	2.2	179	14.8	1.6	70	7.4	1.4	69	21.6	3.8
Unmet mental health needs												
Yes	325	36.6	2.5	129	12.4	1.7	45	7.0	1.7	42	18.5	4.3
No	744	6.2	0.3	246	2.0	0.2	85	0.8	0.1	78	12.3	2.0
Length of deployment												
Not Deployed	388	8.7	0.7	140	2.8	0.3	47	1.2	0.3	46	13.9	2.8
1 to 12 months	248	9.9	0.9	81	3.2	0.5	38	2.0	0.5	33	18.2	4.4
More than 12 months	433	6.5	0.4	154	2.3	0.2	45	0.7	0.1	41	9.7	1.9
Risk profiles												
Class 1	11	38.9	12.2	6	21.6	10.2	3	11.4	8.6	3	29.4	19.7
Class 2	252	34.5	2.7	117	17.2	2.1	46	8.2	1.8	45	23.4	4.6
Class 3	470	25.2	1.6	166	6.9	0.7	55	2.7	0.5	50	10.0	1.9
Class 4 (low risk)	210	2.2	0.2	53	0.5	0.1	13	0.2	0.1	9	6.0	2.4
Class 5	126	7.9	1.0	33	2.0	0.6	13	1.2	0.5	13	14.7	5.8

Notes: Risk profiles: the five classes represent Class 1 – illegal drug use; Class 2 – mental health needs with tobacco and alcohol use; Class 3 – mental health conditions only; Class 4 – low risk (SMs with low levels of illegal drug use, mental health visits, tobacco use, and alcohol use); Class 5 – alcohol use.

lower and upper confidence limits of (95% CI: LCL and UCL). The test is considered significant if the 95% CI does not contain the value 1.0. To detect unobserved heterogeneity and identify qualitatively different subgroups within the population based on patterns of covariate responses, we used LCA within a social determinant of health framework.[23] LCA analysis was performed in Mplus (Version 8.8), and the LCA model included twenty items on substances and mental health conditions. The number of classes were selected based on goodness-of-fit statistics such as the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). LCA syntax in Mplus can be found in Appendix 1. We explored the association between suicidal behaviors and risk profiles by using the Rao-Scott chi-square test.

Results

Table 1 demonstrates the prevalence estimates and sociodemographic characteristics of the population. Table 2 illustrates the overall prevalence estimates and across subgroups. The overall past-year prevalence estimates included: SI was found

Table 3 Unadjusted/Adjusted Odds Ratio Estimates of Past-Year SI and SA by Socio-Demographic Characteristics

Category	Past-Year SI						Past-Year SA					
	OR	LCL	UCL	aOR	LCL	UCL	OR	LCL	UCL	aOR	LCL	UCL
Gender												
Female	**1.37**	**1.13**	**1.66**	1.22	0.98	1.51	1.45	0.83	2.55	1.01	0.56	1.81
Male	1.00			1.00			1.00			1.00		
Age												
17–24 years	**1.61**	**1.29**	**2.01**	**1.39**	**1.07**	**1.80**	**4.99**	**2.88**	**8.64**	**4.88**	**2.37**	**10.08**
25–34 years	1.00			1.00			1.00			1.00		
35–44 years	**0.77**	**0.62**	**0.95**	0.86	0.69	1.07	1.10	0.61	1.96	1.12	0.60	2.11
≥ 45 years	**0.42**	**0.29**	**0.60**	**0.52**	**0.36**	**0.76**	0.64	0.24	1.67	0.66	0.24	1.84
Education												
High school or less	1.00			1.00			1.00			1.00		
Some college	**0.62**	**0.48**	**0.81**	0.87	0.64	1.18	**0.23**	**0.11**	**0.49**	0.56	0.25	1.22
College degree	**0.42**	**0.34**	**0.51**	**0.72**	**0.54**	**0.96**	**0.37**	**0.20**	**0.67**	1.81	0.71	4.65
Race												
Black	0.95	0.71	1.28	0.79	0.58	1.09	1.19	0.55	2.56	1.00	0.44	2.29
Hispanic	0.94	0.71	1.25	0.77	0.57	1.02	1.17	0.53	2.57	0.89	0.41	1.93
Other	0.90	0.66	1.22	0.79	0.57	1.09	0.64	0.33	1.26	0.59	0.29	1.20
White	1.00			1.00			1.00			1.00		
Marital status												

Cohabiting	**1.98**	**1.41**	**2.77**	**1.49**	**1.03**	**2.15**	**3.45**	**1.50**	**7.94**	1.81	0.69	4.70
Never Married	**1.58**	**1.26**	**1.98**	1.17	0.91	1.52	**2.62**	**1.30**	**5.27**	1.20	0.52	2.79
Separated, Divorced, or Widowed	**2.48**	**1.77**	**3.46**	**2.41**	**1.70**	**3.41**	**5.13**	**2.01**	**13.05**	**5.31**	**1.97**	**14.29**
Married	1.00			1.00			1.00			1.00		
Obese												
Yes	**1.35**	**1.06**	**1.71**	**1.53**	**1.19**	**1.97**	0.87	0.46	1.64	1.17	0.60	2.27
No	1.00			1.00			1.00			1.00		
LGB												
Yes	**2.24**	**1.70**	**2.94**	**1.87**	**1.40**	**2.51**	**2.92**	**1.56**	**5.43**	**2.24**	**1.24**	**4.05**
No	1.00			1.00			1.00			1.00		
Service branch												
Army	**1.76**	**1.38**	**2.25**	**1.88**	**1.46**	**2.40**	**2.25**	**1.13**	**4.46**	**2.33**	**1.17**	**4.62**
Marine Corps	**2.20**	**1.72**	**2.80**	**2.00**	**1.55**	**2.58**	**2.53**	**1.31**	**4.91**	1.83	0.93	3.59
Navy	**2.34**	**1.85**	**2.96**	**2.18**	**1.71**	**2.79**	**2.56**	**1.34**	**4.89**	**2.35**	**1.17**	**4.71**
Coast Guard	0.96	0.67	1.39	1.01	0.69	1.46	**0.24**	**0.08**	**0.71**	**0.29**	**0.09**	**0.88**
Air Force	1.00			1.00			1.00			1.00		
Rank												
Officer	**0.42**	**0.34**	**0.52**	**0.72**	**0.54**	**0.96**	**0.22**	**0.12**	**0.40**	**0.28**	**0.11**	**0.71**
Enlisted	1.00			1.00			1.00			1.00		

Note: Boldface indicates statistical significance (p = 0.05).
Abbreviations: SI, suicide ideation; SA, suicide attempt; OR, unadjusted odds ratio; aOR, adjusted odds ratio.

Table 4 Unadjusted/Adjusted Odds Ratio Estimates of Past-Year SI and SA by Health Behaviors

Variable	Past-Year SI						Past-Year SA					
	OR	LCL	UCL	aOR	LCL	UCL	OR	LCL	UCL	aOR	LCL	UCL
Number of cigarettes/days past 30 days	1.04	1.01	1.07	1.03	1.01	1.06	1.04	1.02	1.06	1.03	1.01	1.05
Number of e-cigarettes past 30 days	1.04	1.03	1.05	1.03	1.02	1.04	1.05	1.03	1.07	1.03	1.01	1.06
Smoke status												
Cigarettes only	1.96	1.47	2.60	1.66	1.23	2.23	1.56	0.73	3.35	1.36	0.61	3.02
E-cigarettes only	2.46	1.73	3.51	2.00	1.38	2.88	4.25	1.82	9.95	2.64	1.14	6.08
E-cigarettes and Cigarettes	3.78	2.78	5.15	3.01	2.20	4.12	6.84	3.40	13.76	4.67	2.31	9.44
None	1.00			1.00			1.00			1.00		
Heavy alcohol use												
Yes	2.58	1.98	3.37	2.18	1.65	2.89	1.95	0.94	4.05	1.52	0.74	3.11
No	1.00			1.00			1.00			1.00		
Drug misuse												
Yes	3.90	2.16	7.02	3.69	2.06	6.60	7.78	2.43	24.83	7.39	2.15	25.43
No	1.00			1.00			1.00			1.00		
Mental health visits												
1 to 2	2.56	1.76	3.74	2.43	1.63	3.63	0.55	0.15	1.98	0.51	0.14	1.92
3 to 9	5.26	3.93	7.03	5.30	3.94	7.14	8.74	3.84	19.91	8.95	3.89	20.57
≥ 10	11.10	8.68	14.20	10.79	8.28	14.06	17.39	9.39	32.20	16.95	8.00	35.90
None	1.00			1.00			1.00			1.00		
Unmet mental health needs												
Yes	8.68	6.80	11.06	7.89	6.08	10.22	8.91	4.81	16.51	8.41	4.29	16.45
No	1.00			1.00			1.00			1.00		
Kessler psychological distress scale (K6)	1.21	1.18	1.23	1.20	1.17	1.22	1.22	1.16	1.28	1.21	1.15	1.27
Post-traumatic stress disorder (PC-PTSD-5)	1.67	1.54	1.81	1.65	1.51	1.79	1.39	1.11	1.75	1.30	1.03	1.65
Length of deployment												

1 to 12 months	1.22	0.94	1.58	**1.39**	**1.04**	**1.85**	1.59	0.82	3.08	**2.39**	**1.19**	**4.81**
More than 12 months	**0.76**	**0.62**	**0.94**	1.03	0.78	1.36	**0.53**	**0.30**	**0.95**	1.41	0.67	2.99
Not Deployed	1.00			1.00			1.00			1.00		
Risk profiles												
Class 1	27.78	9.93	77.76	13.64	4.56	40.80	62.18	9.95	388.58	44.71	6.01	332.71
Class 2	22.98	16.82	31.41	18.42	13.23	25.66	43.12	17.93	103.70	29.88	11.66	76.58
Class 3	14.73	11.24	19.31	14.33	10.78	19.06	13.23	5.75	30.45	12.67	5.23	30.68
Class 4 (low risk)	1.00			1.00			1.00			1.00		
Class 5	3.74	2.63	5.31	3.11	2.19	4.41	5.66	1.81	17.68	4.34	1.45	12.98

Notes: Risk profiles: the five classes represent Class 1 – illegal drug use; Class 2 – mental health needs with tobacco and alcohol use; Class 3 – mental health conditions only; Class 4 – low risk (SMs with low levels of illegal drug use, mental health visits, tobacco use, and alcohol use); Class 5 – alcohol use. SI, suicide ideation; SA, suicide attempt; OR, unadjusted odds ratio; aOR, adjusted odds ratio. Each health behavior was analyzed in controlling for socio-demographic characteristics: sex, race age, education, marital status, obesity, lesbian, gay, or bisexual (LGB), service branch, and rank. Boldface indicates statistical significance (p = 0.05).

among 8.3% (95% CI: 7.50–9.02%), suicide plans 2.7% (95% CI: 2.31–3.15%), and SA among 1.2% (95% CI: 0.90–1.59%). SA among SMs reporting SI was found among 14.2% (95% CI: 10.46–17.92%). Differences in prevalence patterns were observed by demographic data, mental health conditions, substance use, and risk profiles (Table 2). For instance, prevalence of SI decreased with increasing age (11.1% among ages 17–24, 7.3% among ages 25–35, 5.6% among ages 35–44, and 3.1% among ages 45+ (F_{317163}= 24.9, P < 0.0001)); as did SA (2.5% among ages 17–24, 0.5% among ages 25–35, 0.6% among ages 35–44, and 0.3% among ages 45+ (F_{317163}=6.9, P = 0.0001)).

We found no association between SI and SA and race and ethnicity. However, we did observe differences in these outcomes by sex, age, and race and ethnicity (Figure 1). For example, among younger women (ages 17–24), the prevalence of SI was significantly higher among White women 16.6% (SE = 2.1) ($F_{1,991}$=10.9, P = 0.001) and Hispanic women 16.4% (SE = 3.5) ($F_{1,543}$=6.2, P = 0.013) than among Black women 5.8% (SE = 2.4). In contrast, among older women aged 45 years or more, the prevalence of SI was significantly higher in Black women 9.0% (SE = 3.7) than among White women 1.6% (SE = 0.8) ($F_{1,301}$=4.4, P = 0.037). The intermediate prevalence of SI found among Hispanic women (5.9%, SE = 4.2) was not statistically different from either Black women ($F_{1,94}$= 0.32, P = 0.575) or White women ($F_{1,258}$= 1.0, P = 0.307).

Table 3 shows that several sociodemographic factors were associated with increased adjusted odds of both SI and SA, including: younger age; lower education level; being divorced, separated, or widowed; LGB; enlisted rank; and service in the Army or Navy.

Table 4 presents the unadjusted associations between SI and SA and health behaviors and mental health history, as well as their associations after adjusting for the sociodemographic variables shown in Table 3. This shows a significant association between both SI and SA and the number of cigarettes/days for the past 30 days, number of e-cigarettes for the past 30 days, number of mental health visits, unmet mental health needs, PC-PTSD-5 scale, K6 scale, and history of deployment of less than 12 months. The only covariate associated with increased adjusted odds of SI but not SA was cigarette only (without e-cigarette) use. SI and SA were strongly associated with drug misuse, e-cigarettes only, and dual use of e-cigarettes and cigarettes. Figure 2 illustrates latent classes of substance use and mental health profiles. A five-
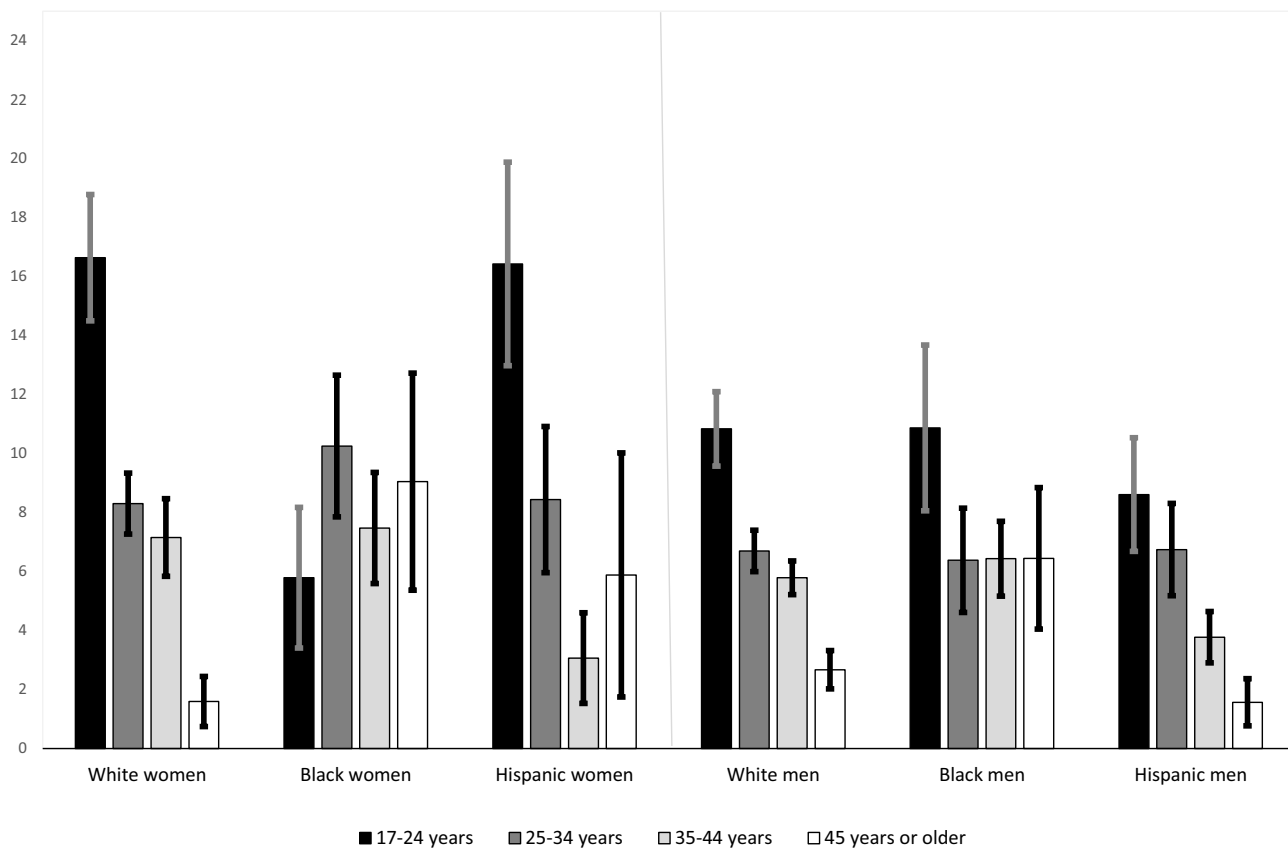
Figure 1 Weighted prevalence (%) of past-year suicide ideation (SI) (y-axis) among active-duty SMs by race/sex (x-axis) and age groups. Error bars represent 95% CIs.
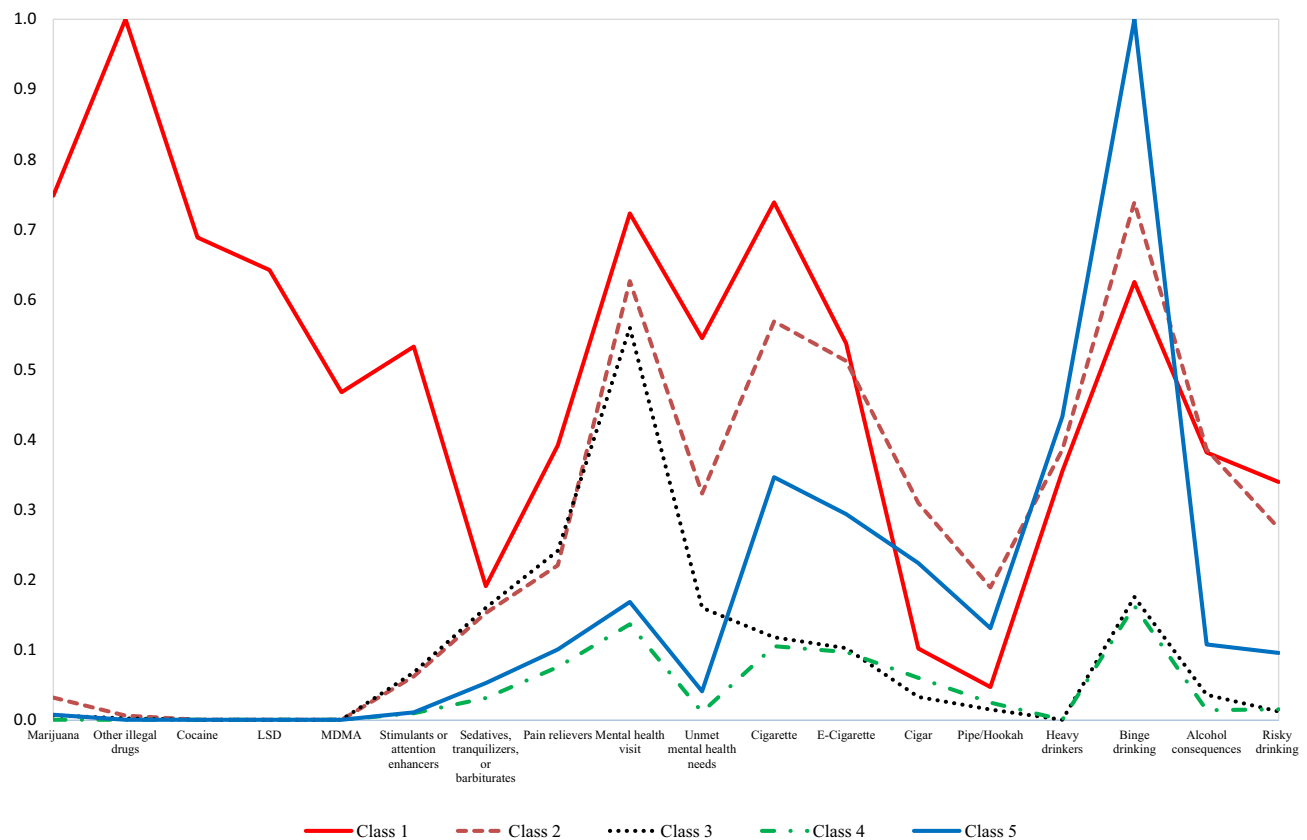
Figure 2 Estimated proportions (y-axis) of the 20 items of mental health conditions and substance use (x-axis). Latent class analysis (LCA) selected five-class solution given by class 1 ("illegal drug use", 0.63%), class 2 ("mental health needs with tobacco and alcohol use", 5.44%), class 3 ("mental health conditions only", 13.15%), class 4 ("low risk" SMs with low levels of illegal drug use, mental health visits, tobacco use, and alcohol use, 65.09%), and class 5 ("alcohol use", 15.70%). Service members of class 1, 2, and 3 were more likely to report mental health visits and serious distress. Binge drinking was more common among service members of class 5, 2, and 1.

class solution was chosen (BIC = 164,392.7, AIC = 163,586.6, entropy = 0.81, and Log-likelihood P < 0.0001). Class 4 ("low risk", 64.84%) consisted of the majority of SMs and had low levels of illegal drug use, mental health visits, tobacco use, and alcohol use. Class 1 ("illegal drug use", 0.63%) had the smallest proportion of SMs and was characterized by high levels of illegal drug use, as well as having high levels of mental health needs, tobacco use, and heavy alcohol use. Class 2 ("mental health needs with tobacco and alcohol use", 6.45%) was similar to class 1 but without the illegal drug use. Class 3 ("mental health needs only", 12.22%) had high levels of mental health needs but otherwise had low risk behaviors similar to class 4. Class 5 ("alcohol use", 15.86%) was also similar to class 4 but had the highest levels of alcohol use and moderate levels of tobacco use. Prevalence estimates of SI and SA significantly varied by classes (Figure 3). For instance, class 1 ("drug use", 38.9% and 11.4%), class 2 ("mental health needs with tobacco and alcohol use", 34.5% and 8.2%), and class 3 ("mental health conditions only", 25.2% and 2.7%) had significantly higher prevalence estimates of SI and SA than class 4 ("low risk", 2.2% and 0.2%), respectively. Compared to those of class 4 'low risk', class 1, 2, and 3 SMs were more likely to report past-year SI and SA (Table 4).

Discussion

We analyzed the representative DoD survey to estimate the prevalence of SI and SA and their associated factors among active-duty SMs. We found that one in twelve (8.26%) and one in eighty (1.25%) SM reported past year SI and SA, respectively.

We found that sociodemographic factors associated with increased adjusted odds of both SI and SA included younger age; lower education level; being divorced, separated, or widowed; LGB; enlisted rank; and service in the Army or Navy. Among the mental health and health behavior covariates, we found strong associations between both SI and SA and
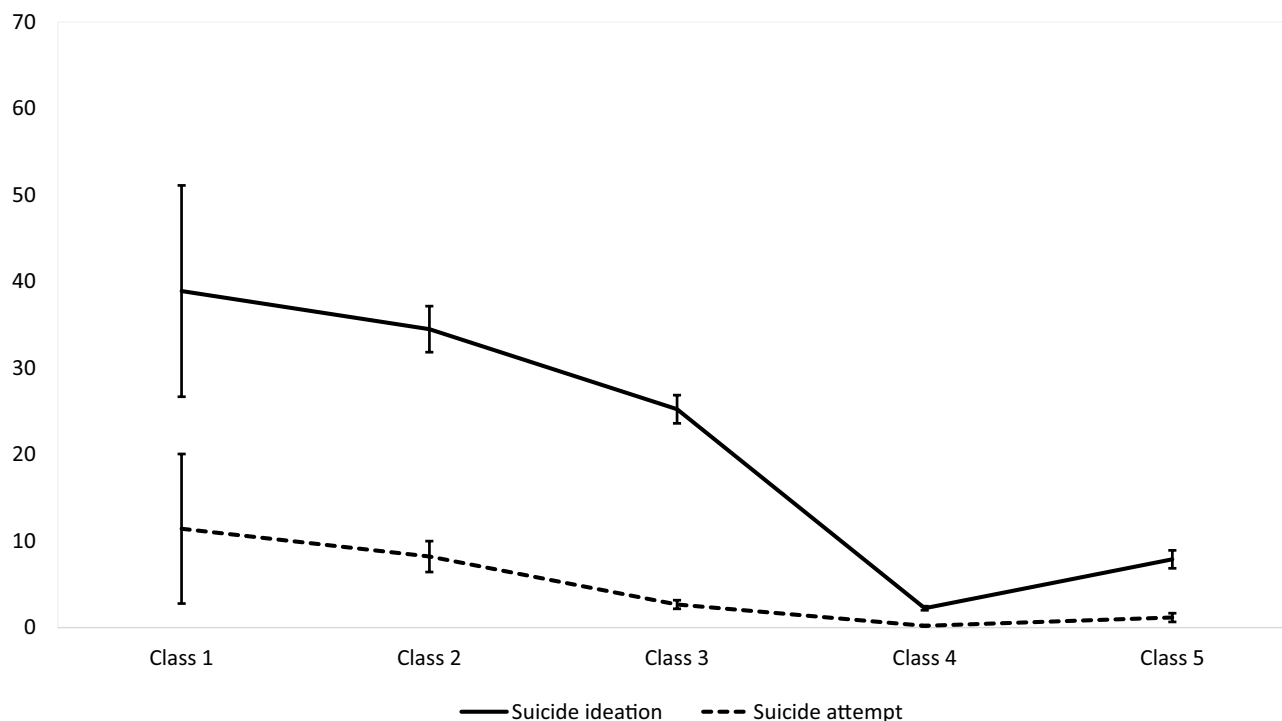
Figure 3 Weighted prevalence estimates (%) of suicidal ideation and attempts among active-duty SMs (y-axis) in each of the five risk profiles (x-axis). Class 1 "drug use" was most likely to have experienced past-year SI and SA (38.9% and 11.4%), respectively. Followed by class 2 "tobacco use" (38.4% and 7.4%), and class 3 "mental health conditions" (28.4% and 4.5%), respectively. Service members of class 1, 2, and 3 had significantly higher prevalence of SI and SA than service members with "low risk" class 4 (1.8% and 0.2%), respectively. Error bars represent 95% CIs.

serious distress, mental health visits, PTSD, and unmet mental health needs. SI and SA were strongly associated with drug misuse, e-cigarettes only, and dual use of e-cigarettes and cigarettes.

SMs were clustered into five classes based on their substance use and mental health conditions. SMs with class 1 characteristics of "illegal drug use" were most likely to have both SI and SA. Those with characteristics of class 2 "mental health needs with tobacco and alcohol use" and class 3 "mental health conditions only" also had high levels of SI but progressively lower levels of SA.

While the prevalence of SI among 18–25 years old in the general US population was 3.4% in 2018,[24] our study discovered a significantly higher prevalence of 11.1% (95% CI: 9.5–12.7%) among SMs in this same age range (or category). In contrast, the prevalence of SA among 18–25 years old in the general population was 1.9%,[24] which was consistent with 2.45% (95% CI: 1.6–3.3%) among SMs of the same age. Snarr et al reported a past-year SI estimate in a sample limited to the Air Force SMs and found 3.8%.[10] This is consistent with our past-year SI estimate when we limited our sample to the Air Force SMs of 4.8%. Our estimate of the proportion of SMs with SA (12%) among those who had SI was also slightly higher than that reported previously (8.7%) among Air Force SMs.[10] Demographic factors, mental health conditions, and health behaviors associated with SI and SA were also consistent with the literature. SI and SA have been found to be associated with posttraumatic stress disorder, intermittent explosive disorder, panic disorder, and depression among Army soldiers,[8] similar to our findings that both SI and SA were strongly associated with mental health conditions. Our study revealed that substance use such as drug misuse, e-cigarettes use, and dual use of e-cigarettes and cigarettes have been identified as risk factors for SI and SA. Similarly, Naifeh et al reported substance use associated with an increased risk of SA,[25] and Campbell-Sills et al noted associations between nicotine dependence and increased odds of SI and SA among a sample of Army soldiers.[26] We found consistent evidence that the number of cigarettes/day for the past 30 days and number of e-cigarettes for the past 30 days were both significantly associated with SI and SA, indicating the odds increasing by 0.3% for every additional cigarette or e-cigarette used. Mental health counselors or psychiatrists

might consider screening for the level of tobacco dependence of an adolescent, and adolescent should, therefore, be carefully assessed as part of the psychiatric evaluation and management.

Naifeh et al also found that enlisted SMs deployed within the first 12 months of service have the highest risk of SA,[27] and Ursano et al reported higher odds of SA among enlisted soldiers in the sixth month of deployment.[18] These are similar to our findings of higher SI and SA prevalence among SMs deployed for less than 12 months and among younger and enlisted SMs.

Several studies have reported significantly higher prevalence of reporting suicidal behaviors among servicewomen[12–14] and among the white race.[14–16] In our study, suicidal behaviors did not differ by gender or race but did differ by their intersectional identities when stratified by age groups. For instance, young White servicewomen had a higher prevalence of SI when compared to young Black servicewomen. Contrastingly, White servicewomen aged 45+ had a lower prevalence of SI when compared to Black servicewomen aged 45+. These findings improve our understanding on how race, gender, and age may relate to suicidal behaviors and can help identify SMs at high risk.

Limitations

The data obtained for this study was obtained through a confidential web-based cross-sectional survey as opposed to anonymous, allowing for administrative data to be linked to responses. The remainder of the data included self-reported assessments of exposures and outcomes. The cross-sectional design precludes a causal interpretation of the associations found in this study due to the uncertain temporal relationship between exposures and outcomes. Self-reported assessments may have resulted in information bias due to perceived social desirability of responses, as well as possibly recall bias for those who had the outcomes. Although K6 and PC-PTSD-5 were reliable and valid to measure SA and SI in SMs, their optimal cutpoints might depend on psychiatric diagnosis and the population under study. There was no information about the type of mental illness, syndromic level, chewing tobacco, and snuff use. The low response rate likely resulted in non-response bias. However, we applied survey weights in all analyses to correct for the low survey response and selection bias. The results of this study may only apply to the US military population, as this population receives full direct care in the Military Health System and wider accessibility to behavioral and mental health clinics.[28]

Conclusions

The burden of SI is large among active-duty SMs compared to the general US population, particularly among younger SMs. This may be due to military stressors such as combat trauma, non-combat trauma, bullying, sexual assault, legal problems, relationship problems, or other factors.[15] It is also noteworthy that 47% to 58% of those with suicidal behaviors first occurred prior to entry into military service.[8] Nevertheless, this large burden of SI among active-duty SMs suggests the need for intensive interventions to detect, mitigate, and prevent these conditions. Our and other study findings suggest that SI and SA among SMs are associated with mental health conditions, health disparities and certain demographic groups, and health behaviors.

A large burden of mental health conditions in the US military population has been reported,[29] with increased awareness of and demand for mental health services among SMs. Despite the resources and increased access to mental health support, the prevalence of SI among active-duty SMs appears greater than in the general population of the same age, likely due to additional military exposures and stressors. This study suggests that since mental health conditions are most strongly associated with SI and SA, the identification of these conditions is a critical element in the prevention and control of SI and SA. These study findings further highlight the magnitude of the public health challenge associated with SI and SA in the DoD and support the need for new strategies with high efficacy that are aimed at mitigating SI and SA. These strategies include evidence-based clinical mental health assessments using standardized and validated interviews and measures; evidence-based interventions such as dialectical behavior and cognitive therapies; and evidence-based prevention such as means restriction, provider and community-based education, and establishing a culture which promotes mental health and physical safety.[19]

This study also highlights the need for targeted effective prevention methods to address disparities in suicidal behaviors, including the higher prevalence of SI and SA among those of enlisted rank or with LGB identity. These groups have been suggested as priority populations for DoD health equity efforts.[30] These and other demographic factors may also be used to identify and target interventions to those at highest risk, including not only enlisted and LGB SMs but also those who are younger, less educated, serve in the Army or Navy, or are divorced, separated, or widowed. This study also suggests that other co-occurring health behaviors are important factors which may influence SI and SA, including the use of drugs, alcohol, and e-cigarettes or

dual-tobacco products. These health behaviors not only have other negative physical health effects which require their own public health and medical interventions but they also may be useful in identifying and targeting interventions to prevent and control the burden of SI and SA. Many of these behaviors were seen to be quite common in this study, and e-cigarette use and dual product use have been noted to be increasing in the military population.[31] Mental health specialists should also consider these health behaviors as part of their mental health assessments and risk stratification for suicidal behaviors.

Data Sharing Statement

The data that support the findings of this study are available from the Defense Health Agency, however restrictions apply to the availability of these data, which were used under license for the current study, and thus are not publicly available.

Ethics Approval and Consent to Participate

The Health-Related Behavior Survey (HRBS) was conducted by the Defense Health Agency. The 2018 HRBS version has been updated and administered by the RAND Corporation. The final survey, the sampling plan, all communication with potential respondents, and the data security plan were reviewed by RAND's Institutional Review Board (known as the Human Subjects Protection Committee), the Westat Institutional Review Board, the Coast Guard's Institutional Review Board, the Office of People Analytics, the Office of the Under Secretary of Defense for Personnel and Readiness's Research Regulatory Oversight Office, the Office of the Assistant Secretary of Defense for Health Affairs and the Defense Health Agency's Human Research Protection Office, and the DoD Security Office. All survey materials included the survey report control system license number: DD-HA(BE)2189. Informed consent was required and obtained at the beginning of this web-based survey, and responses were confidential. The current study used secondary data, and the authors analyzed a de-identified data file. Because the data were previously collected and de-identified, the protocol for the present study was deemed exempt (not human subject research) by the Institutional Review Board of the Uniformed Services University of the Health Sciences. All methods were carried out in accordance with relevant guidelines and regulations (Declaration of Helsinki).

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Disclosure

The authors declare no conflicts of interest in this work.

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