Post-Traumatic Stress Disorder Among U.S. Army Drone Operators

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INTRODUCTION: Exposure to traumatic events could increase post-traumatic stress disorder (PTSD) risk among enlisted U.S. Army drone operators. Published research on PTSD risk in this population is unavailable.

METHODS: We used a combined medical and administrative longitudinal dataset to examine adjusted associations between drone operator service among U.S. Army enlisted members and three PTSD indicators: whether screened via the PTSD Checklist – Civilian (PCL-C); PCL-C scores; and incident PTSD diagnoses. We compiled summary statistics for and conducted tests of differences in independent variable distributions when comparing drone operators and others. Two multivariable survival regression models and an ordinary least squares model were used to estimate adjusted associations.

RESULTS: There were 1.68 million person-years of observed time in the study population ($N = 678{,}548$; drone operator $N = 2856$). Compared to other servicemembers, the adjusted likelihood of undergoing PTSD screening was 35% lower [95% confidence interval (CI) for the adjusted hazard ratio (aHR): 0.56–0.76]. Among subjects who took the PCL-C, scores did not differ significantly on the basis of drone operator service (adjusted change: −1.26 points; CI: −3.41–0.89). The adjusted hazard of receiving a PTSD diagnosis was 34% lower among drone operators (CI: 0.54–0.80).

DISCUSSION: These findings provide reassurance that enlisted U.S. Army drone operators are not at increased risk of PTSD. Further research is needed in order to identify the mechanisms of the decreased PTSD risk observed, and whether other or longer-term mental health risks are present among those in this occupation.

KEYWORDS: posttraumatic stress disorder, drone operators, military medicine.

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Exposure to or involvement in human injury or death are risk factors for the development of post-traumatic stress disorder (PTSD).[17,18,22] These exposures are more likely to occur in certain occupations, including emergency services, law enforcement, and the military. Tactical unmanned aerial system or "drone" operators serving in the U.S. military comprise one potentially affected group.

Unlike most conventional warfighters, drone operators may primarily experience traumatic events via a video monitor. Popular news reporting[10,21,25] and some research[27] have altogether raised concerns about possible stress effects and mental health risks associated with service as a military drone operator. Conversely, it has been speculated that such service could result in a video game player-like mentality in which occurrences that are typically disturbing progressively become viewed with less concern or compassion than are live experiences.[1] This theory holds that remote combat experience could be associated with reduced emotional impact, and thus reduced risk of manifesting conditions such as PTSD.

Depending upon the comparison group, researchers have discovered similar or lower rates of overall mental health disorders among military drone operators[24,38] or a mix of findings.[8] Surveys of U.S. Air Force drone operators have found that 10.7% of respondents reported a high level of distress,[9] and 6.2% met PTSD symptom criteria.[7] The need for more research on health effects among military drone operators and the potential increased psychological distress associated with the

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profession were noted after a systematic review of relevant studies.[2]

In contrast to the Air Force and its aviation-related operational focus, the U.S. Army is the American military's primary ground combat force. However, the Army has used its own drones in combat since the Desert Storm conflict of 1991.[35] The Army's drone operators use their aerial platforms to conduct reconnaissance and surveillance in support of military combat operations, including targeting sites and persons for attack.[31,32] The Army's MQ-1C Gray Eagle drone also carries missiles that can immediately engage targets with lethal force.[15]

Beyond the Gray Eagle operator's capacity to directly inflict harm, any of the Army's drone operators could remotely witness lethal engagements performed by others. Their surveillance duties also include carrying out battle damage and casualty assessments in which they may observe decedents or seriously injured persons immediately following such actions. When compared to platforms used by the U.S. Air Force, the Army's drones mostly operate at lower altitudes and reduced ranges and may play more direct supporting roles to fighting units to which operators may also be directly assigned.[23] A possible consequence is that Army drone operators could personally know individuals from their own units who are injured or killed during operations that they remotely witness, which could increase the psychological impact of such events.

As a result of these activities, Army drone operators may experience specific exposures that could precipitate PTSD. Because of their operational differences, it is possible that Army drone operators may experience differing PTSD risks than those in the Air Force or elsewhere. The bulk of prior research has been on Air Force drone operators, and no prior studies appear to have been conducted specifically on U.S. Army operators. The objective of this study was, therefore, to clarify PTSD risks in this group. To do so, we used data from a period of substantial military combat operations in which contemporary exposures might place them at risk for experiencing traumatic events and subsequent PTSD, potentially providing a more abundant set of exposure-outcome relationships and findings that are relevant to the most serious operational situations.

The selected period, 2012–2014, is a useful one in which to capture exposure-outcome trajectories because of the robust U.S. troop presence in Iraq and Afghanistan during that era.[11] This time period encompassed recently concluded U.S. combat operations in Iraq,[20] ongoing operational support of Iraqi forces' combat missions,[5,14] and continuing U.S. combat operations in Afghanistan.[6] This time period was studied rather than using data from a much more contemporary time period because full-scale U.S. combat operations have been minimal in recent years. Since PTSD symptoms can appear within 3 mo of precipitating traumatic events, and some sufferers recover within 6 mo,[22] it is likely useful to observe a time period during which recent exposure to combat operations was commonplace.

While PTSD diagnoses represent important endpoints for study, they may lag substantially behind symptomatic onset. We therefore also examined leading indicators of PTSD that could appear before a clinical diagnosis is documented. To accomplish this, we leveraged the Behavioral Health Data Portal or BHDP, a health care platform with functions including capture of mental health instruments administered to U.S. military service members.[30]

The BHDP archives include the PTSD Checklist–Civilian or PCL-C symptom scale, a PTSD screening instrument that provides a unitless response scale of 17 to 85 corresponding to potential PTSD severity.[39] While a military-focused version of the PCL is also available, the PCL-C is commonly administered to service members. It has proven reliable when used in military and veteran populations[28,40] and provides the flexibility to assess PTSD arising from a range of exposures. In addition to the results of PCL-C tests, we were also interested in potential differences in rates of its administration between drone operators and others as possible indicators of differing levels of personal and/or clinician suspicion of PTSD.

We combined PCL-C, clinical encounter data, and administrative data in longitudinal datasets based on service by Army members over time. The approach was intended to permit robust control for sociodemographic factors, location effects, and overall occupational exposures associated with the military lifestyle, including combat exposure. The data were employed to answer three questions:

1) Were drone operators at an increased adjusted likelihood of being screened for PTSD using the PCL-C?
2) Among service members who took the PCL-C, did drone operators demonstrate higher or lower adjusted PCL-C scores than others?
3) Were drone operators at an increased adjusted risk of receiving a new PTSD diagnosis when compared to other population members, and when controlling for the presence and results of PCL-C testing?

METHODS

Subjects

The study protocol was approved in advance by the institutional review board of the Stanford University School of Medicine and underwent secondary review by the human research protections office of the Defense Health Agency. We used only secondary data that were collected noninvasively by the Department of Defense as a part of normal military and medical operations, reflecting events during work, training, and health care that the subjects would have undertaken had no study existed. Identifiers were removed from all data to produce limited datasets in which no persons could be identified; therefore informed consent of the subjects was not applicable.

To support observation for outcomes and their predictors over time, the longitudinal "panel" data structure was based on the person-specific active-duty time served by all enlisted members of the U.S. Army during 2012–2014. This information was derived using official personnel records originally sourced from the U.S. Defense Manpower Data Center.[36] Time-varying and -invariant events were represented by variables described below. Relevant variable values were arrayed across the observed person-time for each subject to ensure correct inference with respect to temporal relationships, and to permit time-to-event regression analyses.

Equipment and/or Materials

We employed three dependent variables to address our three research questions. The first variable was administration of the PCL-C, captured in the BHDP. To test whether drone operators were more or less likely to be screened for PTSD, we assigned a dichotomous variable upon the first appearance of such testing. The first PCL-C administration was used to create this variable in order to examine whether drone operators were more or less likely to undergo screening for PTSD. This approach was taken because subsequent tests would likely represent monitoring during follow-up care. The second dependent variable was the initial PCL-C score among those soldiers who completed the PCL-C. This was essential for testing whether drone operators demonstrated higher or lower adjusted PCL-C scores than others.

The third dependent variable was a diagnosis of PTSD. To identify such diagnoses, we drew upon clinical identification of PTSD in out- or inpatient care using the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code 309.81. ICD-9-CM was the coding system used during our data period. ICD-9-CM data were obtained from electronic health record extracts archived in the Military Health System Data Repository.[37] In addition to ICD-9-CM diagnoses, we also used the documentation of PTSD diagnoses as free-text entries in the "eProfile" system, which is used to document clinical restrictions on training or combat deployment. The eProfile system is complementary to the electronic health record and began digitally archiving medically based duty restrictions in January 2011.[3]

Among our independent variables, the main exposure of interest was military service in the drone operator occupation. Across the longitudinal data representing service by all enlisted members of the Army, those identified as drone operators were assigned the "1" value for a dichotomous independent variable in any observed month in which they held a "15W" military occupation identifier[32] as the primary occupation. Such statuses were identified using the aforementioned Defense Manpower Data Center[36] official personnel records. All other person-months were assigned the "0" reference value. The longitudinal data, therefore, permitted observation of individuals who held the drone operator occupation at some times but not others, such as in the case of occupation changes.

To support control for potential sociodemographic confounders, personnel records provided multiple other factors. Sex was encoded as a dichotomous variable per the service member's reporting. The personnel data also identified each person's age in years at each point in the longitudinal panel. We created a continuous age variable and a quartile version based on the population distribution. We further noted that Black Americans have been found to experience a higher PTSD prevalence than those in other races.[26] To address this factor, we encoded race using a four-category variable based on servicemembers' self-report in personnel records (White, Black, Asian or Pacific Islander, and a combined category for other, mixed, or unknown race).

Personal support from significant others could also influence PTSD risk.[29] We thus used personnel records to encode a categorical independent variable for three possible marital statuses: married, never married, and formerly married (including legally separated, divorced, or widowed). Religious faith can constitute a further form of personal support; an inverse association between spiritual well-being and PTSD symptom severity has been reported among U.S. Air Force drone operators.[41] Our data provided a view on spirituality through stated religious preference, which the Army records for its members. We therefore created a categorical variable representing four combined faith-based groups: all Christian faiths and Judaism, combined; atheist, agnostic, or reporting of no religious affiliation; non-Christian religions commonplace in southern and southwest Asia, including Islam and Hinduism, collectively referred to herein as "Eastern" religions; and a group of other belief systems that may not align with traditional classification, such as Wicca.

Aptitude scores determine eligibility for military service in general and for occupational assignments therein such as to drone operator duty.[34] Aptitude scores may also relate to health literacy[16] and its potential contribution to a range of outcomes including PTSD. We therefore leveraged results of the Armed Forces Qualification Test,[34] which was provided as a numeric scale from 0 to 99. This factor was configured as a categorical variable based on quartiles of test scores, plus a category for those with missing data. Scores were also formulated as continuous values for certain analyses.

To control for the recency of combat exposure, if any, we created a five-category variable of the quartiles of the running duration of time since prior combat experience, plus a fifth category for no combat experience. We additionally posited that the total quantity of active military service could be related to PTSD risk, although potentially in a nonlinear fashion. More service time could decrease risk of PTSD, through extinction effects, or alternatively, could raise risk through cumulative effects or increased opportunities for traumatic experiences over time. We therefore also organized each member's total, running active-duty service time as a continuous value and as a four-category variable. Some subjects had already served in the Army for various prior durations when first observed, and it is possible for Army soldiers to change military occupations. Therefore, the service time value included unobserved and observed service for some subjects, and some subjects held multiple military occupations during their total service.

PCL-C score values were configured into a quartile-based categorical variable, plus a category for having no observed PCL-C data. Our modeling against incident PTSD in question 3 relied upon the longitudinal data panel in which multiple PCL-C tests were possible before or in the absence of a diagnoses. As this structure provided for multiple potential PCL-C administration events over time, we wished to observe the association with the last known PCL-C data as of each time point. Therefore, for the incident PTSD models, we arranged PCL-C scores as running variable values over time for each applicable member reflecting the last score, if any.

Statistical Analysis

Descriptive statistics were computed as of the last person-specific observation. Tabulations of each categorical variable were organized by drone operator status, with Chi-squared tests used to assess unadjusted associations between the variables and drone operator status. Among categorical factors that were based on continuous values, we also used *t*-tests to compare mean values among those who were and were not drone operators.

Dedicated, multivariable regression analysis approaches were employed to provide adjusted assessments of the association between holding the drone operator occupation and each of the three outcomes when controlling for the other factors. The dichotomous endpoint representing the first appearance of PCL-C testing was the outcome for the Cox proportional hazards models used for the first question. This model was run on a longitudinal subset of the data in which observation ceased at the first such test for those with such data, or the end of overall observable time for others. We employed ordinary least squares regression in a one-record-per-subject dataset to model PCL-C scores when addressing the second question. For the third question, we used the entire longitudinal panel in which subjects were censored after a first PTSD diagnosis, or at the end of the observed time for those without PTSD.

RESULTS

Among the 678,548 subjects, 2856 (0.42%) served as a drone operator at some point during the observed time period. There was a total of 1.68 million person-years available for observation of all persons in the dataset before the first PTSD diagnosis for affected individuals or before the end of observation for the remaining subjects. Overall, subjects were observed for a mean of 2.48 yr (median: 2.50, standard deviation: 1.33).

Table I displays the tabulations of independent variables used in the regression models as of the last available person-specific observation. In these bivariate analyses, drone operators were more likely to be male, white, and single than other subjects. Drone operators were over-represented in the two youngest age categories, possessing a 2-yr lower mean age than other enlisted Army members (respective means: 26.20 vs. 28.25 yr, $P < 0.001$). Drone operators were also modestly more prevalent among those stating atheist, agnostic, or no religious preference or who reported a nontraditional religious affiliation when compared to other subjects.

Referring again to Table I, we found that drone operators were disproportionately represented among the highest aptitude score categories and among subjects with no combat experience. Operators were much less likely to have their most recent combat experiences >48 mo in the past than other enlisted Army members. Among those with prior combat experience, drone operators had significantly less time since their last combat deployment (18.96 mo vs. 26.59 mo, $P < 0.001$) than nonoperators. Drone operators were also overrepresented among those in the lowest categories of active military service time, with a correspondingly lower mean service time among drone operators when compared to others (respectively, 5.2 vs. 6.9 yr, $P < 0.001$).

Per Table I, only 6.23% of drone operators took the PCL-C during the observed time, whereas 9.31% of other subjects did so ($P < 0.001$). Among all subjects who took the PCL-C, 34.83% of the operators had PCL-C scores in the lowest quartile (with a score of ≤32) compared to 23.85% of others. Above that threshold, drone operators were underrepresented in each quartile of the scores and had a lower mean PCL-C score than other enlisted members, respectively, scoring 41.67 vs. 44.15 ($P = 0.024$). The proportion of drone operators with diagnoses of PTSD was less than half that observed among nonoperators (3.26% vs. 6.87%, $P < 0.001$).

Table II, **Table III**, and **Table IV** provide the results of analyses using regression models that provided effect estimates for each independent variable that adjust for the other variables that were included in the same models. The findings of the survival model for the presence or absence of PTSD screening are in Table II. Observation for this analysis ceased upon the first appearance of a PCL-C test and, hence, the total observation time of 1642,265.50 person-years in this analysis was lower than the total time available in our dataset that was reported for the descriptive statistical analysis above. Subjects in this analysis of PCL-C screening were observed for a mean of 2.42 yr (median: 2.42, standard deviation: 1.31).

Per Table II, the regression-adjusted hazard (conditional probability) of PTSD screening was significantly lower among drone operators than others [adjusted hazard ratio (aHR): 0.65; 95% confidence interval (CI): 0.56–0.76; $P < 0.001$]. The probability of PCL-C screening was higher, overall, among female subjects compared to male subjects (aHR: 1.63; CI: 1.59–1.66; $P < 0.001$). In terms of the race categories studied, we saw essentially identical adjusted hazards of screening for Black subjects compared to White, but significantly lower adjusted rates of screening among subjects of Asian and Pacific Islander descent and among subjects in the "other, mixed, or unknown" race category compared to White soldiers. Persons who were married or formerly married were slightly more likely to have had PCL-C screening compared to those who were never married. Service members in the "other" belief system group had the highest adjusted probability of PTSD screening among religious faith categories when compared to those of Christian or Jewish faith (aHR: 1.49; CI: 1.37–1.61; $P < 0.001$).

As further seen in Table II, the likelihood of taking the PCL-C was inversely related to aptitude scores in a monotonic fashion, with those in the lowest aptitude score category having the highest probability of PCL-C screening. Compared to subjects with no history of combat deployment, the likelihood of screening was lower for those with any amount of time since deployment, but particularly for those with very recent deployments (aHR = 0.56; CI: 0.54–0.57; $P < 0.001$). The PTSD

Table I. Characteristics of Drone Operators Compared to All Others in a Population of U.S. Army Soldiers ($N = 678{,}548$) with Results of Chi-Squared Tests for Category Distribution Differences and *t*-Tests for Differences in Means of Continuous Values.

FACTOR	SUBPOPULATION COUNT (PERCENTAGE OF TOTAL*) FOR CATEGORIES; MEAN [MEDIAN, STANDARD DEVIATION] FOR CONTINUOUS VALUES		*P*-VALUE (X^2 VALUE, DEGREES OF FREEDOM)
	DRONE OPERATOR 2856 (0.42)	OTHER 675,692 (99.58)	
Gender			
Men	2612 (91.45)	581,852 (86.11)	<0.001 (68.02, 1)
Women	244 (8.55)	93,840 (13.89)	
Age, years			
≤21	574 (20.10)	105,771 (15.65)	<0.001 (227.56, 3)
22 to 25	1059 (37.08)	198,736 (29.41)	
26 to 30	695 (24.33)	165,045 (24.43)	
≥31	528 (18.49)	206,140 (30.51)	
Mean [median, SD[†]]	26.20 [25.00, 5.97]	28.25 [26.00, 7.29]	<0.001
Race			
White	2396 (83.89)	465,389 (68.88)	<0.001 (310.35, 3)
Black	287 (10.05)	148,784 (22.02)	
Asian or Pacific Islander	84 (2.94)	25,179 (3.73)	
Other, mixed or unknown	89 (3.12)	36,340 (5.38)	
Marital status			
Married	1387 (48.56)	368,004 (54.46)	<0.001 (102.93, 2)
Never married	1376 (48.18)	268,089 (39.68)	
Formerly married	93 (3.26)	39,599 (5.86)	
Religious affiliation			
Christian or Jewish	1926 (67.44)	475,870 (70.43)	0.001 (16.09; 3)
Atheist, agnostic or none	887 (31.06)	188,100 (27.84)	
Eastern religions	21 (0.74)	6691 (0.99)	
Other religions	22 (0.77)	5031 (0.74)	
Armed Forces Qualification Test (AFQT) scores			
≤45	178 (6.23)	201,950 (29.89)	<0.001 (998,16; 4)
46 to 60	656 (22.97)	170,281 (25.20)	
61 to 75	947 (33.16)	146,529 (21.69)	
≥76	1066 (37.23)	151,807 (22.47)	
No data	9 (0.32)	5125 (0.76)	
Mean [median, SD[†]]	69.85 [70.00, 15.59]	58.86 [56.00, 19.22]	<0.001
Time since last combat deployment, months[‡]			
No deployments	1188 (41.60)	260,346 (38.53)	<0.001 (183.37, 4)
<6	364 (12.75)	70,314 (10.41)	
6 to 11.9	328 (11.48)	52,886 (7.83)	
12 to 47.9	866 (30.32)	225,303 (33.34)	
≥48	110 (3.85)	66,843 (9.89)	
Mean [median, SD[†]]	18.96 [15.00, 17.44]	26.59 [20.00, 23.74]	<0.001
Total active military service time, years			
≤2.5	943 (33.02)	188,368 (27.88)	<0.001 (228.85, 3)
>2.5 to 4.5	849 (29.73)	160,655 (23.78)	
>4.5 to 10	714 (25.00)	165,927 (24.56)	
>10	350 (12.25)	160,742 (23.79)	
Mean [median, SD[†]]	5.16 [3.75, 4.96]	6.86 [4.33, 6.53]	<0.001
Took the Post-traumatic Stress Disorder (PTSD) Checklist – Civilian (PCL-C)			
Yes	178 (6.23)	62,932 (9.31)	<0.001 (32.01, 1)
No	2678 (93.77)	612,760 (90.69)	
PCL-C score distribution among subjects who took the test, with percentages of that group only:			
≤32	62 (34.83)	15,009 (23.85)	<0.001 (12.27, 3)
33 to 42	37 (20.79)	15,904 (25.27)	
43 to 54	37 (23.60)	16,245 (25.81)	
≥55	42 (23.6)	15,774 (25.07)	
Mean [median, SD[†]]	41.67 [39.00, 15.05]	44.15 [43.00, 14.69]	0.024
Diagnosed with PTSD			
Yes	93 (3.26)	46,453 (6.87)	<0.001 (58.29, 1)
No	2763 (96.74)	629,239 (93.13)	

[*]Column percentage totals for each variable may not equal 100 due to rounding; [†]Standard deviation; [‡]Computation of time since deployment was limited to the subjects with a deployment history ($N = 1668$ drone operators; $N = 415{,}346$ others).

Table II. Adjusted Hazard Ratios (aHRs) for All Independent Variables from a Multivariable Cox Proportional Hazards Model Assessing Associations of Selected Factors with Whether Screened for Post-traumatic Stress Disorder (PTSD) via the PTSD Checklist–Civilian (PCL-C) Among U.S. Army Service Members ($N = 678,548$).

FACTOR*	aHR	95% CONFIDENCE INTERVAL	*P*-VALUE
Drone operator (referent: all others)	0.65	0.56–0.76	<0.001
Female gender (referent: men)	1.63	1.59–1.66	<0.001
Age, years (referent: 26 to 30)			
≤21	1.45	1.40–1.50	<0.001
22 to 25	1.07	1.05–1.10	<0.001
≥31	1.03	1.01–1.06	0.016
Race (referent: White)			
Black	1.00	0.98–1.02	0.666
Asian or Pacific Islander	0.73	0.69–0.76	<0.001
Other, mixed or unknown	0.86	0.83–0.89	<0.001
Marital status (referent: never married)			
Married	1.07	1.05–1.09	<0.001
Formerly married	1.12	1.09–1.16	<0.001
Religious affiliation (referent: Christian or Jewish)			
Atheist, agnostic or none	1.05	1.03–1.07	<0.001
Eastern religions	1.32	1.22–1.42	<0.001
Other religions	1.49	1.37–1.61	<0.001
Armed Forces Qualification Test (AFQT) scores (referent: ≥76)			
≤45	1.41	1.38–1.45	<0.001
46 to 60	1.30	1.27–1.33	<0.001
61 to 75	1.22	1.19–1.25	<0.001
No data	1.25	1.13–1.39	<0.001
Time since last combat deployment, months (referent: no deployments)			
<6	0.56	0.54–0.57	<0.001
6 to 11.9	0.96	0.93–0.99	<0.001
12 to 47.9	0.98	0.96–1.01	<0.001
≥48	0.88	0.85–0.91	<0.001
Total active military service time, years (referent: ≤2.5)			
>2.5 to 4.5	0.42	0.41–0.44	<0.001
>4.5 to 10	0.46	0.44–0.48	<0.001
>10	0.36	0.35–0.37	<0.001

*The aHR for each variable's reference status was 1.00.

Table III. Regression Coefficients (Changes in Scores) Associated with Independent Variables Reflecting Adjustment Using a Multivariable Least-Squares Regression Model for Post-traumatic Stress Disorder Checklist–Civilian (PCL-C) Scores Among Screened U.S. Army Soldiers ($N = 63,110$).

FACTOR	COEFFICIENT	95% CONFIDENCE INTERVAL	*P*-VALUE
Drone operator (referent: all others)	−1.26	−3.41–0.89	0.250
Female gender (referent: men)	−0.90	−1.20 – −0.59	<0.001
Age, years (referent: 26 to 30)			
≤21	0.41	−0.08–0.90	0.098
22 to 25	−0.32	−0.67 – −0.03	0.073
≥31	0.63	0.25–1.01	0.001
Race (referent: White)			
Black	2.24	1.95–2.52	<0.001
Asian or Pacific Islander	2.06	1.37–2.75	<0.001
Other, mixed or unknown	1.23	0.72–1.74	<0.001
Marital status (referent: never married)			
Married	0.58	0.29–0.88	<0.001
Formerly married	1.74	1.22–2.26	<0.001
Religious affiliation (referent: Christian or Jewish)			
Atheist, agnostic or none	−0.18	−0.44 – −0.08	0.167
Eastern religions	2.55	1.41–3.69	<0.001
Other religions	−0.88	−2.05–0.29	0.140
Armed Forces Qualification Test (AFQT) scores (referent: ≥76)			
≤45	3.16	2.82–3.50	<0.001
46 to 60	2.54	2.19–2.89	<0.001
61 to 75	1.74	1.38–2.10	<0.001
No data	1.44	−0.04–2.91	0.056
Time since last combat deployment, months (referent: no deployments)			
<6	0.79	0.37–1.22	<0.001
6 to 11.9	1.25	0.79–1.70	<0.001
12 to 47.9	1.14	0.76–1.52	<0.001
≥48	1.17	0.64–1.71	<0.001
Total active military service time, years (referent: ≤2.5)			
>2.5 to 4.5	−0.31	−0.72–0.10	>2.5 to 4.5
>4.5 to 10	−0.43	−0.90–0.05	0.079
>10	−1.70	−2.28 – −1.11	<0.001

screening probability also decreased with service time, with particularly low probabilities among those with >10 yr of active military service (aHR = 0.36; CI: 0.35–0.37; $P < 0.001$) compared to those in the lowest active military service category, ≤2.5 yr.

Table III lists the findings of the multivariable ordinary least squares model for the initial PCL-C score among subjects who were so screened in the absence of prior PTSD diagnoses ($N = 63,110$). No significant difference in PCL-C scores was observed comparing drone operators with others (coefficient: −1.26 points; CI: −3.41–0.89; $P = 0.250$). Female subjects had significantly lower PCL-C scores than did male subjects, and subjects over 30 yr old significantly higher scores than those 26 to 30 yr old. Compared to White subjects, those in each of the other race categories had significantly higher scores, with adjusted differences ranging from 1.23 to 2.24 points.

Compared to never-married subjects, those who were married had slightly lower scores, but formerly married individuals saw higher scores (Table III). Affiliation with the Eastern religion group was associated with a PCL-C score that was 2.55 points higher than those in the reference group, Christian or Jewish faith (CI: 1.41–3.69; $P < 0.001$). Scores on the PCL-C were progressively higher with lower aptitude scores. This pattern culminated in the highest effect estimate seen in this regression model, which was found when comparing subjects with aptitude scores 45 or lower to those with scores greater than 75 (coefficient: 3.16; CI: 2.82–3.50; $P < 0.001$).

Subjects with less than 6 mo since the last combat deployment scored 0.79 points lower on the PCL-C (CI: −1.22 – −0.37; $P < 0.001$) than those with no combat experience. However, having any greater time since deployment was associated with score increases of 1.14 to 1.25. Compared to subjects with 2.5 or fewer years of active military service, having over 2.5 yr was associated with score decreases, with the highest decrease observed for those with over 10 yr of service (coefficient: −1.70; CI: −2.28 – −1.11; $P < 0.001$).

Table IV provides the findings of the Cox proportional hazards model for incident PTSD diagnoses in the total study population ($N = 678,548$). Drone operator status was associated with a significant reduction in the adjusted PTSD diagnosis hazard (aHR = 0.66; CI: 0.54–0.80; $P < 0.001$). In terms of other

Table IV. Adjusted Hazard Ratios (aHRs) for All Independent Variables from a Multivariable Cox Proportional Hazards Model Computing Their Associations with Diagnoses of Post-Traumatic Stress Disorder (PTSD; $N = 678{,}548$).

FACTOR*	aHR	95% CONFIDENCE INTERVAL	*P*-VALUE
Drone operator (referent: all others)	0.66	0.54–0.80	<0.001
Female gender (referent: men)	1.17	1.14–1.20	<0.001
Age, years (referent: 26 to 30)			
≤21	0.91	0.86–0.96	0.001
22 to 25	0.94	0.91–0.97	<0.001
≥31	1.16	1.13–1.19	<0.001
Race (referent: White)			
Black	0.78	0.76–0.80	<0.001
Asian or Pacific Islander	0.64	0.60–0.67	<0.001
Other, mixed or unknown	0.89	0.86–0.92	<0.001
Marital status (referent: never married)			
Married	1.36	1.33–1.40	<0.001
Formerly married	1.32	1.27–1.38	<0.001
Religious affiliation (referent: Christian or Jewish)			
Atheist, agnostic or none	0.95	0.93–0.97	<0.001
Eastern religions	1.24	1.31–1.37	<0.001
Other religions	1.29	1.18–1.41	<0.001
Armed Forces Qualification Test (AFQT) scores (referent: ≥76)			
≤45	1.67	1.63–1.72	<0.001
46 to 60	1.49	1.44–1.53	<0.001
61 to 75	1.33	1.29–1.37	<0.001
No data	1.41	1.29–1.55	<0.001
Time since last combat deployment, months (referent: no deployments)			
<6	2.19	2.11–2.88	<0.001
6 to 11.9	3.34	3.20–3.49	<0.001
12 to 47.9	3.07	2.96–3.20	<0.001
≥48	2.85	2.72–2.99	<0.001
Total active military service time, years (referent: ≤2.5)			
>2.5 to 4.5	1.75	1.67–1.83	<0.001
>4.5 to 10	2.09	1.99–2.19	<0.001
>10	2.03	1.93–2.14	<0.001
PTSD Checklist – Civilian (PCL-C) score (referent: no PCL-C tests recorded)			
≤32	3.00	2.78–3.24	<0.001
33 to 42	6.75	6.39–7.13	<0.001
43 to 54	11.29	10.77–11.82	<0.001
≥55	20.53	19.74–21.37	<0.001

*The aHR for each variable's reference status was 1.00.

predictors, the hazard was slightly reduced when comparing those in either the 21 or younger group or subjects 22 to 25 yr old with those 26 to 30, but subjects over 30 were at modestly greater risk. Among race categories, the adjusted PTSD diagnosis hazard was highest in Whites compared to all other groups.

Per Table IV, vs. subjects who were unmarried, those who were currently or formerly married were at an increased adjusted hazard of a PTSD diagnosis. Those in the "other" belief system subset and the Eastern religion group each had modestly greater PTSD hazards when compared to Christian or Jewish faith, while those stating atheist, agnostic, or no religious status had a slightly lower hazard. Risk increased in a relatively monotonic fashion with decreasing aptitude scores.

As also seen in Table IV, the adjusted PTSD diagnosis hazard increased from twofold to threefold or more among subjects with prior deployments when compared to those without any deployments. The risk increase was highest among those with 6 to 11.9 mo since the last combat deployment (aHR: 3.34; CI: 3.20–3.49; $P < 0.001$). The PTSD diagnosis hazard was lowest among those with ≤2.5 yr of service and subjects in all other service time categories were generally at similar, roughly twofold increases in the hazard.

Finally, per Table IV, the risk of a PTSD diagnosis rose to very high levels as PCL-C scores increased. This pattern culminated in a greater than 20-fold elevation if scoring 55 or more points (CI: 19.74–21.37; $P < 0.001$). However, even when scoring ≤32 points, the adjusted hazard of a diagnosis was three times that experienced by those with no PCL-C data (CI: 2.78–3.24; $P < 0.001$).

DISCUSSION

In this large study population of the U.S. Army and its drone operators in a time of ongoing combat activity, we found that operators were less likely to undergo PTSD screening using the PCL-C (Table II). Drone operators who were administered the PCL-C had very similar mean scores on that test to those of other Army members (Table III). They were at lower adjusted probabilities of PTSD diagnoses (Table IV) than other U.S. Army service members.

Multiple possible reasons could exist for these findings. The theorized "video game player" phenomenon, in which remote experiences could carry less emotional impact with time due to repeat exposures, appears plausible.[1] However, there is the potential for self-selection effects or selection measures taken by the military for those who enter the drone operator profession. It is also possible that, to avoid medically directed duty restrictions and to be able continue to perform in their work, drone operators could knowingly downplay their symptoms to a greater degree than most soldiers, reducing screening and diagnosis probabilities as well as PCL-C test scores.

Exploration of all such phenomena would require qualitative study that exceeds the scope of this analysis. Nonetheless, leaders and clinicians might be reassured that despite the aforementioned concerns expressed in popular media, in these data, we do not see increased PTSD indicators or diagnosis rates in the U.S. Army drone operator population. However, the lower probability of PCL-C administration among those with any deployment history compared to those who never deployed (Table II) bears some consideration. Possible explanations include a selection effect in which service members with mental health problems and susceptibilities may have been reduced in the subgroup that had ever deployed. This effect could be driven by self- or externally directed selection out of units that deploy or of the Army population itself.

A related possible explanation is that noncombat traumatic exposures—including those prior to military service—may be substantial in this population, prompting early screenings in the undeployed group that in turn lead to selection processes. If true, such phenomena could provide further validation of the U.S. military's past use of the PCL-C rather than the military version of the instrument. A sizable percentage of the population had never deployed and a range of possible traumatic histories and effects could have been experienced in this population, just as in any civilian group. While we did see higher PCL-C scores and higher PTSD diagnosis rates among those who have deployed, the findings for screening suggest that the use of a broader screening approach may be justified.

Findings of changing risks for each outcome that were associated with differing religious affiliations recorded in administrative records could prove helpful for the U.S. Army's policies for handling the prevention and treatment of PTSD. Chaplains assigned to Army units have generally seen an increased role as a mental health care resource for soldiers.[4] Our evidence could help justify more targeted action by chaplains for service members with unique spiritual perspectives.

Armed Forces Qualification Test (AFQT) scores were associated with remarkably consistent effect estimates across all three regression analyses. Decreasing AFQT scores were associated with the most compelling statuses: having undergone PTSD screening, which was plausibly prompted by clinical indications for most subjects; among those tested, higher scores on the PCL-C; and receiving diagnoses of PTSD. These findings suggest the importance of considering health literacy and the ways that patients process information. Practical applications of these findings might deserve consideration, such as targeted education or clinical efforts based on aptitude levels.

The wealth of modest to large effect sizes for non-PCL-C factors in the PSTD diagnosis model (Table IV) indicates that a range of net PTSD risk levels might exist across the population due to the factors that clinicians may not be able to or know to assess. The U.S. Army has already deployed a regression-based risk-stratification system for occupational disability[13] using many of the same data sources employed in our analysis. Our findings indicate that a similar risk stratification tool could potentially be created for PTSD and perhaps other mental health disorders, providing surveillance of total risk in a manner that clinicians cannot currently pursue.

Limitations of this work include that the ability to generalize to other groups such as drone operators in non-U.S. Army military populations is unknown. As previously discussed, operators in other military services may operate with different exposures, capabilities, and missions than those used by the U.S. Army. Readers should also be aware that the PCL-5 has become a common evaluation tool for PTSD in the U.S. military since the time of our data, and the PCL-C may only be used today in limited settings.[19] Therefore, new research may be needed to determine how today's testing approach in the U.S. military predicts PTSD-related endpoints. Otherwise, the study was potentially limited by imprecision in PTSD diagnoses made by clinicians.

A more general concern is that we have only examined short-term phenomena during military service. The 2-yr window in which we assessed subjects means that some who did not receive observed PTSD diagnoses potentially went on to receive later diagnoses due to delayed presentation or assessment. PTSD rates may, therefore, have been modestly underestimated in our analysis. Whether other, longer-term mental health effects associated with drone operator service could be present remains an open question. More research over lengthier time periods and with expanded consideration of mental health outcomes in this occupation are needed.

We also acknowledge that the U.S. Army includes a small number of members in higher pay grades called warrant officers who function as drone operators.[33] This study focused on the much more numerous enlisted members who are junior to them, in light of the differing socioeconomic and other exposure differences that enlisted members and warrant officers may experience. For example, warrant officers may have previously performed or may be eligible for manned aircraft pilot duties that enlisted Army members do not perform. They can engage in senior leadership roles that enlisted members cannot. Further study may be warranted in order to determine whether the findings seen here generalize to warrant officer drone operators.

In conclusion, we found that drone operators are at lower adjusted risks of undergoing PTSD screening and of PTSD diagnoses compared with other enlisted service members in the U.S. Army. These findings of reduced risk provide evidence that PTSD rates are not a great concern for this group, which is important given expectations of how warfare may change in the future. The total drone operator time in U.S. military operations will likely continue to increase; for example, drone capabilities have been increasingly integrated into U.S. Army units as a part of the Soldier Borne Sensor initiative.[12] Further quantitative and qualitative study appears needed to better understand the associations we have found, and to fully understand the scope of mental health risks that accompany the drone operator occupation.

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