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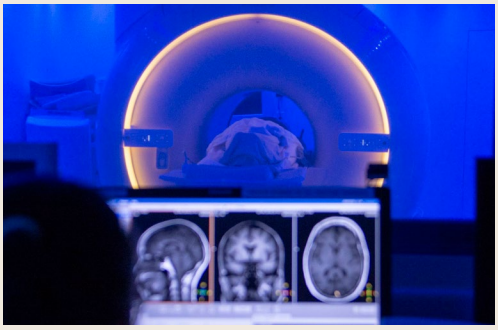

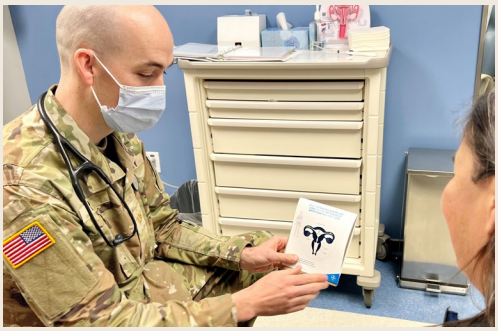

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The Association of Deployment-related Probable Traumatic Brain Injury with Subsequent Medical Readiness Status

Andrew J. MacGregor, PhD; Amber L. Dougherty, MPH; James M. Zouris, MS; Sarah M. Jurick, PhD

Traumatic brain injury (TBI) has been a major source of morbidity within military forces during the last 2 decades, but research on the relationship between TBI and medical readiness is limited. This study population included 41,442 service members from the U.S. Navy and Marine Corps who completed a Post-Deployment Health Assessment (PDHA) and a Periodic Health Assessment (PHA). Presence of TBI was ascertained from a screening instrument on the PDHA, and provider determination of medical readiness was abstracted from the PHA. Multivariable logistic regression assessed the association between probable TBI and 'not medically ready' (NMR) service member disposition while adjusting for covariates. Overall, 1.8% of the study population screened positive for TBI, and individuals with TBI had a significantly higher prevalence of NMR disposition (7.8%) than those without (3.7%). After adjusting for all covariates, TBI was associated with higher odds of post-deployment NMR disposition (odds ratio 1.5; 95% confidence interval, 1.2 - 2.0). Deployment-related TBI is associated with medical readiness. Future studies are needed to elucidate the TBI sequelae that may lead to NMR disposition as well as the impact of repeated TBIs.

What are the new findings?

This study identified 54% increased odds of 'not medically ready' disposition for military personnel with probable traumatic brain injury (TBI) following deployment, after adjusting for post-traumatic stress disorder and other co-variates.

What is the impact on readiness and force health protection?

This analysis measures the association of TBI with medical readiness, which could inform future TBI screening, referral, and patient management protocols. Awareness of this association is particularly important in times of high operational tempo, during which maintaining force readiness through multiple deployment cycles is imperative.

Traumatic brain injury (TBI) is a prevalent condition in the U.S. military. It is estimated that as many as 1 in 5 service members experienced possible TBI during combat deployment in Iraq and Afghanistan.[1] This estimate was primarily attributed to the widespread use of blast weaponry by the enemy, which caused more than 70% of combat casualties.[2] New research suggests that the risk of TBI among military personnel may be even higher in conflicts with "near peer" adversaries and more advanced weapons.[3]

Besides combat operations, TBI can also occur in military personnel as a result of training, accidents, sports activities, and occupational exposure (e.g., low-level blasts).[4-7] The TBI Center of Excellence reported 485,553 TBI incidents between 2000 and the second quarter of 2023.[8] TBI is an important medical condition for military leadership to consider during times of war and peace.

Sequelae of TBI include neurological, physical, sensory, and psychological complaints that can often co-occur, sometimes leading to multimorbidity.[9,10] This includes a strong association with post-traumatic stress disorder (PTSD), an anxiety disorder resulting from exposure to a traumatic event, which can complicate TBI treatment.[11] TBI among military personnel may have an extended symptom course compared to the anticipated recovery trajectory,[12] even showing a deleterious effect on quality of life several years after the injury.[13]

Health care costs associated with TBI are also significant. A recent study estimated that the median cost of combat-related TBI during the first year after injury was $129,655 for moderate-to-severe TBI and $74,810 for mild TBI,[14] although this did not account for the financial impact of TBI on readiness (i.e., ability of military personnel to deploy in support of operations). With an all-volunteer force and recent lags in recruiting,[15] maintaining medical readiness among current military service members is essential.

There is a gap in the literature on the association between TBI and medical readiness, and quantifying this issue is essential for advising medical planners, clinicians, and policy-makers. The objective of this study was to examine the association between deployment-related TBI and post-injury not medically ready (NMR) disposition. Two standardized health questionnaires, the Post-Deployment Health Assessment (PDHA) and the Periodic Health Assessment (PHA), were used to identify TBI and NMR disposition, respectively.

Methods

Data were abstracted from the PDHA and PHA for service members in the Navy and Marine Corps. The PDHA is a screening questionnaire given to personnel at the conclusion of deployment, with questions on a variety of deployment-related health issues including TBI and PTSD.[16] The PHA is an annual health questionnaire for all service members that features a provider determination of medical readiness status.[17]

For personnel with at least 1 completed PDHA (DD FORM 2796, Oct. 2015) between January 1, 2016 and December 31, 2019, the most recent PDHA was selected. These data were linked to the first PHA (DD FORM 3024, Apr. 2016) that was completed and certified by a health care provider within 18 months after the completion of the selected PDHA. This methodology resulted in an initial study population of 42,914. A total of 1,472 personnel were excluded from analysis due to missing data for independent or dependent variables, leaving a final study population of 41,442.

Presence of TBI was measured using a PDHA screening instrument that is based on the Brief Traumatic Brain Injury Screen.[18] This screening instrument asks respondents if they experienced an injury event (e.g., blast or explosion, vehicular accident or crash, fragment or bullet wound, or other injury) and whether that injury event resulted in a loss or alteration of consciousness. Those endorsing both an injury event and a loss or alteration of consciousness were classified as 'TBI screen positive', i.e., probable TBI. PTSD was also measured on the PDHA using the Primary Care PTSD Screen, on which endorsement of 2 of the 4 PTSD questions indicated a PTSD screen positive.[19]

NMR disposition and all other covariates were abstracted from the PHA. Presence of NMR disposition was obtained from the Individual Medical Readiness Disposition Determination section on the PHA completed by a health care provider. NMR is defined on the PHA as "Service members with a chronic or prolonged deployment-limiting medical or mental condition as described in DoDI 6490.07."

Time between each PDHA and PHA was calculated in days and entered as a continuous variable for analysis. Age was categorized in years, as 18-24, 25-29, 30-34, 35-39, and 40 and older, sex was categorized as male or female, service as Navy or Marine Corps, military rank as enlisted or officer, and service component as active or reserve/national guard.

Univariate analysis examined NMR disposition and all covariates for those with and without probable TBI, using Chi-square and t-tests for categorical and continuous variables, respectively. Multivariable logistic regression assessed the relationship between probable TBI and NMR disposition while adjusting for all covariates. Odds ratios (ORs) and 95% confidence intervals (CIs) were reported. The Hosmer-Lemeshow test was used to evaluate model fit with an alpha level of 0.1. All analyses were conducted in SAS version 9.4 (Cary, NC).

Results

Descriptive statistics are presented in **Table 1**. The study population was primarily younger than 30 years old (61.4%), male (90.2%), in the Marine Corps (58.8%), enlisted (83.2%), and active duty (79.7%) at time of PHA. The prevalence of PTSD positive screenings and NMR disposition was 4.6% and 3.7%, respectively; on average, the PHA was completed 239 days (SD 150) after the PDHA.

Overall, the prevalence of screening positive for TBI was 1.8% (760/41,442). All variables, except rank and time between PDHA and PHA, differed significantly by probable TBI. Individuals with probable TBI were more likely than those without to be older, female, in the Navy, and reserve or national guard. Most notably, those with probable TBI (27.6%) had a significantly higher prevalence of probable PTSD than those without TBI (4.1%). NMR disposition was significantly higher (7.8%) in military personnel with probable TBI compared with those without TBI (3.7%; $p<0.001$).

Results from the multivariable logistic regression are shown in **Table 2**. Service members who screened positive for TBI on the PDHA, compared with those who did not, were significantly more likely to have a post-injury NMR disposition on the PHA (OR 1.5; 95% CI, 1.2 - 2.0). The strongest associations with NMR disposition were a positive screening for PTSD (OR 2.5; 95% CI, 2.1 - 2.9), female sex (OR 1.9; 95% CI, 1.6 - 2.2), and reserve or national guard status (OR 2.0; 95% CI, 1.8 - 2.2). The Hosmer-Lemeshow test indicated the model as a good fit ($p>0.10$).

Discussion

In this analysis, probable deployment-related TBI was associated with 54% increased odds of post-injury NMR disposition among Navy and Marine Corps personnel. This finding has implications for military medical and operational planning, and future research is needed to determine the effects of specific TBI sequelae on this relationship. We identified associations between a positive screen for PTSD and both probable TBI and NMR disposition, which emphasizes the need to account for PTSD when studying TBI and related outcomes among military personnel.

The prevalence of TBI in the present study was only 1.8%, which is lower than in earlier studies from the conflicts in Iraq and Afghanistan in which TBI screen positive rates ranged from 15% to 23%.[20-22] This difference may be attributable to operational tempo during the study period, whereby the present analysis excluded earlier years of the post-9/11 overseas contingency operations that were characterized by high operational tempo and injury rates.[23,24] All deployments were also included in this study, rather than only those to a combat zone, as in the previous research. Altogether, this suggests the effect of probable deployment-related TBI on medical readiness may be greater at times of high operational tempo, when there may be an increased risk of injury, which could be exacerbated by protracted operations in which military personnel are expected to deploy multiple times to a combat zone. Epstein et al. (2023)[3] posited that TBI may occur at a greater incidence in future

conflicts against 'near peer' adversaries, which makes the study of TBI and medical readiness even more critical.

It is important to determine the specific symptoms of TBI that may drive the relationship between deployment-related TBI and post-deployment NMR disposition, as this information could be used to refine screening and referral protocols, as well as patient management guidelines, to maximize medical readiness. Previous research identified associations between specific TBI symptoms and health-related outcomes. For example, post-TBI dizziness and memory problems were associated with declines in self-rated health.[25] Further research is needed to examine the independent effect of deployment-related TBI symptoms on readiness. The 2008 form of the PDHA included questions on the TBI screening instrument that queried service members on current symptoms related to a TBI, but this section was removed on the 2012 form revision and has not been included in subsequent revisions. Nevertheless, the PDHA contains a generalized checklist of symptoms that could be used for this analysis, and data reduction techniques such as latent class or cluster analysis could be employed to identify symptom profiles following deployment-related TBI associated with decreased readiness.[10]

PTSD was the strongest predictor of NMR status in this study. Not surprisingly, PTSD was also associated with TBI, which is consistent with previous literature.[11] It is important to note that many TBI symptoms overlap with PTSD,[21] and prior research has shown that, after accounting for PTSD, the relationship between TBI and several self-reported TBI symptoms is attenuated. For example, in one study of military personnel, Hoge et al. (2008)[20] found that only headache was independently associated with TBI after adjusting for PTSD, and other studies have yielded similar findings.[21,25] As such, it is important to account for PTSD and potential symptom overlap with TBI while examining the short- and long-term impacts of TBI in military populations. Furthermore, clinicians should consider

TABLE 1. Characteristics of the Study Population by Traumatic Brain Injury Screening Status

Characteristic	Total (n=41,442)		TBI Positive Screen (n=760)		TBI Negative Screen (n=40,682)		*P*-value
	No.	%	No.	%	No.	%	
Age, y							<0.001
18-24	15,568	37.6	179	23.6	15,389	37.8	
25-29	9,885	23.9	191	25.1	9,694	23.8	
30-34	6,904	16.7	132	17.4	6,772	16.7	
35-39	4,655	11.2	117	15.4	4,538	11.2	
40+	4,430	10.7	141	18.6	4,289	10.5	
Sex							<0.001
Male	37,393	90.2	647	85.1	36,746	90.3	
Female	4,049	9.8	113	14.9	3,936	9.7	
Service branch							<0.001
Navy	17,060	41.2	374	49.2	16,686	41	
Marine Corps	24,382	58.8	386	50.8	23,996	59	
Rank							0.950
Enlisted	34,482	83.2	633	83.3	33,849	83.2	
Officer	6,960	16.8	127	16.7	6,833	16.8	
Component							<0.001
Active duty	33,017	79.7	530	69.7	32,487	79.9	
Reserve, National Guard	8,425	20.3	230	30.3	8,195	20.1	
PTSD positive screen							<0.001
No	39,548	95.4	550	72.4	38,998	95.9	
Yes	1,894	4.6	210	27.6	1,684	4.1	
NMR							<0.001
No	39,895	96.3	701	92.2	39,194	96.3	
Yes	1,547	3.7	59	7.8	1,488	3.7	
Time between PDHA and PHA, d		mean (SD)		mean (SD)		mean (SD)	
	239	150	231	154	240	150	0.119

Abbreviations: TBI, traumatic brain injury; n,No., number; y, years; PTSD, post-traumatic stress disorder; NMR, not medically ready; PDHA, Post-Deployment Health Assessment; PHA, Periodic Health Assessment; SD, standard deviation; d, days.

TABLE 2. Multivariable Logistic Regression Examining Not Medically Ready Disposition with Traumatic Brain Injury and Other Covariates

Characteristic	OR	95% CI	*P*-value
TBI positive screen			0.003
No	Reference	-	-
Yes	1.5	1.2 - 2.0	
Age, y			0.002
18-24	Reference	-	-
25-29	0.9	0.8 - 1.0	
30-34	0.9	0.8 - 1.1	
35-39	0.8	0.6 - 0.9	
40+	1.1	0.9 - 1.4	
Sex			< 0.001
Male	Reference	-	-
Female	1.9	1.6 - 2.2	
Service			0.268
Navy	Reference	-	-
Marine Corps	0.9	0.8 - 1.1	
Rank			< 0.001
Enlisted	Reference	-	-
Officer	0.7	0.6 - 0.8	
Component			< 0.001
Active duty	Reference	-	-
Reserve, National Guard	2.0	1.8 - 2.2	
PTSD positive screen			< 0.001
No	Reference	-	-
Yes	2.5	2.1 - 2.9	
Time between PDHA and PHA	1.0	1.0 - 1.0	< 0.001

Abbreviations: OR, odds ratio; CI, confidence interval; TBI, traumatic brain injury; y, years; PTSD, post-traumatic brain injury; PDHA, Post-Deployment Health Assessment; PHA, Periodic Health Assessment.

PTSD when treating military patients with TBI and incorporate multidisciplinary care if necessary to ensure a whole health treatment approach.

The primary strength of this study was the ability to link PDHA with PHA data, which allowed for a direct assessment of medical readiness in a post-deployment population. Using all available data for the Navy and Marine Corps resulted in a robust sample size and ability to detect statistically significant associations when examining NMR disposition, a relatively infrequent event. There were also several limitations. The study population was restricted to only those who deployed and completed both a PDHA and PHA, which may affect the generalizability of the results, as non-deployed service members were not included. These results may also not be generalizable to conflicts during times of high operational tempo. In addition, compliance with the questionnaires can vary. Furthermore, both TBI and PTSD were assessed with a screening instrument, which is not the 'gold standard' approach and cannot parse TBI severity (e.g., mild versus moderate).

The medical readiness disposition determination section on the PHA does not collect information on specific conditions leading to an NMR designation, so it was impossible to determine whether NMR disposition was assigned because of deployment-related TBI. Finally, this study did not assess the effects of multiple deployments, repeated TBI events, or pre- and post-deployment medical conditions, and additional research is needed to account for these factors.

Medical readiness is an important, ongoing issue for the military, and this study indicates that deployment-related TBI is associated with adverse readiness outcomes. Future studies should focus on the relationship between specific TBI sequelae and medical readiness while accounting for co-occurring conditions, such as PTSD, with similar symptomologies. As TBI continues to burden the U.S. military, further research is needed to improve the identification and management of these injuries to ensure individual and force readiness.

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References

1. Swanson TM, Isaacson BM, Cyborski CM, et al. Traumatic brain injury incidence, clinical overview, and policies in the US military health system since 2000. *Public Health Rep*. 2017;132(2):251-259. doi:10.1177/0033354916687748
2. Greer N, Sayer N, Kramer M, Koeller E, Velasquez T. *Prevalence and Epidemiology of Combat Blast Injuries from the Military Cohort 2001-2014*. Department of Veterans Affairs;2016. Accessed Jul. 1, 2024. https://www.hsrd.research.va.gov/publications/esp/blastinjuries-report.pdf
3. Epstein A, Lim R, Johannigman J, et al. Putting medical boots on the ground: lessons from the war in Ukraine and applications for future conflict with near peer adversaries. *J Am Coll Surg*. 2023;237(2):364-373. doi:10.1097/xcs.0000000000000707
4. Van Pelt KL, Allred CD, Brodeur R, et al. Concussion-recovery trajectories among tactical athletes: results from the CARE consortium. *J Athl Train*. 2020;55(7):658-665. doi:10.4085/1062-6050-10-19
5. Le TD, Gurney JM, Singh KP, et al. Trends in traumatic brain injury among U.S. service members deployed in Iraq and Afghanistan, 2002–2016. *Am J Prev Med*. 2023;65(2):230-238. doi:10.1016/j.amepre.2023.01.043
6. Armed Forces Health Surveillance Center. Injuries associated with combat sports, active component, U.S. Armed Forces, 2010-2013. *MSMR*. 2014;21(5):16-18.
7. Martindale SL, Belding JN, Crawford CD, Rowland JA. Validation of military occupational specialty as a proxy for blast exposure using the Salisbury Blast Interview. *J Neurotrauma*. 2023;40(21-22):2321-2329. doi:10.1089/neu.2023.0067
8. Military Health System, U.S. Defense Health Agency. DOD TBI Worldwide Numbers. U.S. Dept. of Defense. Accessed Jul. 1, 2024. https://health.mil/military-health-topics/centers-of-excellence/traumatic-brain-injury-center-of-excellence/dod-tbi-worldwide-numbers
9. Lindberg MA, Sloley SS, Ivins BJ, Marion DW, Moy Martin EM. Military TBI–what civilian primary care providers should know. *J Family Med Prim Care*. 2021;10(12):4391-4397. doi:10.4103/jfmpc.jfmpc_98_21
10. MacGregor AJ, Dougherty AL, D'Souza EW, et al. Symptom profiles following combat injury and long-term quality of life: a latent class analysis. *Qual Life Res*. 2021;30:2531-2540. doi:10.1007/s11136-021-02836-y
11. Scofield DE, Proctor SP, Kardouni JR, Hill OT, McKinnon CJ. Risk factors for mild traumatic brain injury and subsequent post-traumatic stress disorder and mental health disorders among United States Army soldiers. *J Neurotrauma*. 2017;34(23):3249-3255. doi:10.1089/neu.2017.5101
12. Mortimer DS. Military traumatic brain injury. *Phys Med Rehabil Clin N Am*. 2024;35(3):559-571. doi:10.1016/j.pmr.2024.02.008
13. MacGregor AJ, Casachahua JD, Walton SR, et al. Deployment-related concussion and long-term health-related quality of life among US military personnel. *Qual Life Res*. 2023;32(7):1971-1980. doi:10.1007/s11136-023-03367-4
14. Dalton MK, Jarman MP, Manful A, et al. Long-term healthcare expenditures following combat-related traumatic brain injury. *Mil Med*. 2021;187(11-12):1469-1473. doi:10.1093/milmed/usab248
15. Kube C, Boigon K. Every branch of the military is struggling to make its 2022 recruiting goals, officials say. NBC News. Jun. 27, 2022. Accessed Jul. 1, 2024. https://www.nbcnews.com/news/military/every-branch-us-military-struggling-meet-2022-recruiting-goals-officia-rcna35078
16. Office of the Under Secretary of Defense for Personnel and Readiness. DOD Instruction 6490.03: Deployment Health. U.S. Dept. of Defense. Jun. 19, 2019. Accessed Jul. 1, 2024. https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodi/649003p.pdf
17. Office of the Under Secretary of Defense for Personnel and Readiness. DOD Instruction 6200.06: Periodic Health Assessment (PHA) Program. U.S. Dept. of Defense. Sep. 8, 2016. Accessed Jul. 1, 2024. https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodi/620006p.pdf
18. Drake AI, Meyer KS, Cessante LM, et al. Routine TBI screening following combat deployments. *Neuro Rehabilitation*. 2010;26(3):183-189. doi:10.3233/nre-2010-0554
19. Bliese PD, Wright KM, Adler AB, et al. Validating the primary care posttraumatic stress disorder screen and the posttraumatic stress disorder checklist with soldiers returning from combat. *J Consult Clin Psychol*. 2008;76(2):272-281. doi:10.1037/0022-006X.76.2.272
20. Hoge CW, McGurk D, Thomas JL, et al. Mild traumatic brain injury in U.S. soldiers returning from Iraq. *NEJM*. 2008;358(5):453-463. doi:10.1056/nejmoa072972
21. Polusny MA, Kehle SM, Nelson NW, et al. Longitudinal effects of mild traumatic brain injury and posttraumatic stress disorder comorbidity on postdeployment outcomes in National Guard soldiers deployed to Iraq. *Arch Gen Psychiatry*. 2011;68(1):79-89. doi:10.1001/archgenpsychiatry.2010.172
22. Terrio H, Brenner LA, Ivins BJ, et al. Traumatic brain injury screening: preliminary findings in a US Army brigade combat team. *J Head Trauma Rehabil*. 2009;24(1):14-23. doi:10.1097/htr.0b013e31819581d8
23. Goldberg MS. Updated death and injury rates of U.S. military personnel during the conflicts in Iraq and Afghanistan, Working Paper 2014-08. *Working Paper Series*. Congressional Budget Office;2014. Accessed Jul. 1, 2024. https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/workingpaper/49837-Casualties_WorkingPaper-2014-08_1.pdf
24. Howard JT, Kotwal RS, Stern CA, et al. Use of combat casualty care data to assess the US military trauma system during the Afghanistan and Iraq conflicts, 2001-2017. *JAMA Surg*. 2019;154(7):600-608. doi:10.1001/jamasurg.2019.0151
25. MacGregor AJ, Dougherty AL, Tang JJ, Galarneau MR. Postconcussive symptom reporting among US combat veterans with mild traumatic brain injury from Operation Iraqi Freedom. *J Head Trauma Rehabil*. 2013;28(1):59-67. doi:10.1097/htr.0b013e3182596382

Use of Positive Predictive Value to Evaluate the Armed Forces Health Surveillance Division Brain Cancer Incidence Rules, Active Component Department of the Air Force Pediatric Dependent Population, January 1, 2010–December 31, 2020

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The Armed Forces Health Surveillance Division (AFHSD) uses a surveillance case definition to identify malignant brain tumors among U.S. active service members. This case definition was applied to the dependent pediatric population of the active component of the Department of the Air Force, which identified 179 malignant brain cancer cases. Those identified pediatric cases were reviewed using multiple data sources. The positive predictive value (PPV) of the AFHSD case definition was found to be 64.5% (95% confidence interval [CI], 55.9 - 72.5%). In 2019, Webber et al. reported a PPV of 84.3% for brain and other nervous system cancers among U.S. active component officers. The current pediatric study's lower PPV suggests the case definition may be less effective for pediatric populations, indicating a need for refining surveillance methods for dependent populations. The AFHSD case definition was less effective at identifying malignant brain tumors in the active component Air Force pediatric dependent population, with a lower PPV compared to previous studies of the active component Air Force adult population. In addition, several cases were missed by the AFHSD rules.

What are the new findings?

The PPV of the AFHSD case definition was lower when applied to the Air Force pediatric dependent population (64.5%; 95% CI, 55.9-72.5%) compared to the previously published PPV in the adult population (84.3%). There were an additional 16 cases of malignant brain tumors missed by initial screening utilizing AFHSD incidence rules.

What is the impact on readiness and force health protection?

Chronic disease surveillance within the U.S. Department of Defense often relies on the Defense Medical Surveillance System for case identification. Accurate case definitions are essential to accurately identify cases. Further examination of the AFHSD malignant brain tumor case definition is recommended, to more effectively capture cases within the Department of Defense dependent population.

Standard surveillance case definitions and incidence rules by the Armed Forces Health Surveillance Division (AFHSD) are used for routine surveillance and descriptive epidemiological reporting of invasive cancers among active component service members (ACSMs). A malignant brain tumor case definition was developed in 2010 by AFHSD, the Office of the Assistant Secretary of Defense for Health Affairs, the U.S. Army Public Health Command, and the U.S. Military Cancer Institute.[1] The case definition is based on ICD-9 and ICD-10 (International Classification of Diseases, 9th Revision and 10th Revision) codes, scientific literature, and previous AFHSD analysis. These case definitions can be applied to patient encounter data by utilizing diagnostic and treatment codes occurring within specified time periods to identify incident malignant brain tumor cases. Benign brain tumors are not included in this case definition and therefore should not be captured using this methodology.

In 2019, Webber et al. completed a review of multiple cancers in active component U.S. Navy, Air Force, and Marine Corps officers who entered service as company grade officers between January 1, 1986 and December 31, 2006.[2] Of the 121 cases of brain cancer identified by the AFHSD incidence rules, 91 were confirmed brain cancer after chart review, yielding a positive predictive value (PPV) of 84.3%. Cases that were unable to be reviewed (n=13), due to absence of medical records, were not included in the calculation.[2] Validating these case definitions in other populations, such as dependents and retirees, is important for epidemiological studies that use AFHSD case definitions to identify cases among all Military Health System (MHS) beneficiaries.

The current study was prompted by a review of pediatric brain cancer cases among an Air Force base population conducted by the U.S. Air Force School of Aerospace Medicine's Epidemiology Consult Service.[3] The review utilized the AFHSD surveillance case definition to identify cases of malignant brain tumors. The pediatric brain cancer case review included a detailed chart review, which discovered that a proportion of the cases identified by the AFHSD case definition were not malignant brain tumors,

raising concerns about the PPV of the case definition. The objective of the current study is to determine the accuracy of the AFHSD case definition for identifying malignant brain tumors among the active component Department of Air Force (DAF) pediatric dependent population.

Methods

The population of interest was the DAF pediatric dependent population, diagnosed with brain cancer between January 1, 2010 and December 31, 2020 (n=583,244). The cohort, defined as ages 0-19 years, follows the pediatric age grouping established by the Central Brain Tumor Registry of the United States.[4] Potential brain cancer cases were identified utilizing the 3 case-finding methodologies outlined in the AFHSD case definition for malignant brain cancer: 1) hospitalization with malignant diagnosis in first position, 2) hospitalization with a 'Z' or 'V' code for anti-neoplastic treatment in first position and malignant diagnosis code in second position, or 3) ambulatory encounters (within 90 days) with malignant diagnosis in first or second encounters.[2]

The DMSS dataset includes both inpatient and outpatient encounters from military hospitals and clinics (i.e., direct care) as well as care provided at civilian facilities billed to TRICARE (i.e., purchased care). Each identified case was then reviewed by a team comprised of a physician and 3 epidemiologists who examined medical records from multiple systems including the Armed Forces Health Longitudinal Technology Application (AHLTA), Health Artifact and Image Management Solution (HAIMS), Military Health System GENESIS (MHS GENESIS), and Joint Legacy Viewer (JLV). This review extracted clinical notes, pathology reports, imaging results, and other relevant medical documentation to assess whether each individual had a clinician-confirmed diagnosis of primary malignant brain cancer.

Cases were stratified by type of care, either inpatient or outpatient, and direct or purchased, to determine where the largest portion of misclassification occurred. The PPV was calculated as the number of confirmed primary malignant brain cancer cases (i.e., true positives) divided by the sum of cases that were either primary malignant brain cancer cases (true positives) or confirmed as not primary malignant brain cancer cases (i.e., false positives). Cases that were unable to be reviewed, due to absence of medical records in AHLTA, JLV, or MHS GENESIS, were not included in the calculation. The Clopper-Pearson method was used to provide the 95% confidence interval (CI) based on the cumulative probabilities of the binomial distribution.

To identify potentially missed cases, all encounters were scanned for the presence of at least 1 malignant brain cancer ICD-9 or ICD-10 code in any of the first 10 diagnostic positions. Individuals flagged by this filter were further investigated through a detailed electronic health record (EHR) chart review. The same team (1 physician and 3 epidemiologists) completed this additional review, following the same chart review methodology.

Results

The AFHSD case definition identified 179 potential cases of malignant brain tumors within the pediatric dependent population of the U.S. Air Force over an 11-year period of observation. Of those potential cases, 89 were confirmed as true

TABLE. Chart-Confirmed True Positives, False Positives, and Unknown Cases Among All Cases Identified by AFHSD Malignant Brain Tumor Case Definition, Air Force Pediatric Dependent Population, Ages 0-19 Years, January 1, 2010–December 31, 2020

	True Positives		False Positives		Case Classification		
					Confirmed	Unknown	Total Cases
	No.	%[a]	No.	%[a]	No.	No.	No.
Total Cases	89	64.5[b]	49	35.5	138	41	179
Encounter type							
Inpatient	75	54.3	20	14.5	95	18	113
Direct care	43	31.2	11	8.0	54	11	65
Purchased care	32	23.2	9	6.5	41	7	48
Outpatient	14	10.1	29	21.0	43	23	66
Direct care	9	6.5	11	8.0	20	1	21
Purchased care	5	3.6	18	13.0	23	22	45

Abbreviations: AFHSD, Armed Forces Health Surveillance Division; No., number.
[a] Indicates row percentage of confirmed cases.
[b] Positive Predictive Value 64.5% (95% confidence interval, 55.9-72.5%)

positives, 49 as false positives, and 41 cases were not found or were unknown due to a lack of information in EHRs (excluded from PPV calculation). The overall PPV was calculated as 64.5% (95% CI, 55.9-72.4%) **(Table)**.

Inpatient encounters had a higher true positive rate (66.4%) compared to outpatient encounters (21.2%). Within inpatient care, both direct care and purchased care had similar true positive rates (66.2% and 66.6%, respectively). Outpatient encounters showed a notably higher false positive rate (43.9%) compared to inpatient encounters (17.7%). Of the 46 cases identified from outpatient purchased care, 22 were classified as unknown due to insufficient information, 18 were determined to be false positives, and only 5 were confirmed as true positives.

The additional review, which scanned the remaining cohort (n=583,065 dependents) for at least 1 relevant ICD code within the first 10 diagnostic positions, identified 203 potential additional cases. Subsequent chart reviews of these cases confirmed 16 primary malignant brain tumors missed by the AFHSD rules. All 16 missed cases were from outpatient encounters. The reasons for these missed cases varied: 9 cases had a brain cancer ICD code in the first or second diagnostic position but did not have enough of these encounters; 3 cases had 3 outpatient encounters but were spaced 93 to 151 days apart; and 4 cases had the correct ICD codes but not in the first or second diagnostic position.

Discussion

Several factors may explain the lower PPV observed in the current study compared to Webber et al. One notable difference is the higher percentage of potential cases in the current study that could not be reviewed due to missing data (22.3% compared to 14% in Webber et al.). This discrepancy is likely due to unique limitations associated with pediatric populations, which are more likely to be referred to specialized oncology centers, where claims may be processed through alternate systems, potentially bypassing standard DOD medical claims datasets. These referrals often result in cancer-related claim processing outside standard DOD medical claims datasets, contributing to the higher percentage of 'unknowns' in this analysis. Additionally, the 'unknowns' in this study were predominantly identified from outpatient encounters, which are subject to a high false positive rate. While Webber et al. acknowledged that the inclusion of these 'unknowns' could either increase or decrease PPV estimates, the current analysis suggests their inclusion likely contributed to the lower PPV observed in this study. These findings underscore the need to address gaps in data capture and variability in coding practices to improve the accuracy of surveillance case definitions, particularly for pediatric cancer cases.

The challenges in data capture and variability are further compounded by differences in the incidence and presentation of brain tumors in pediatric populations. Brain tumors are less common in children, with an incidence of 5.7 per 100,000 persons in children compared to 29.9 per 100,000 persons in adults.[5] While brain tumors are the most frequent solid cancers observed in children, they often present with non-specific symptoms that may mimic more common childhood illnesses, increasing the likelihood of misdiagnosis or delayed diagnosis.[6,7]

An important limitation of the AFHSD surveillance definitions is reliance on ICD coding practices. Those definitions assume that cancer-related codes will appear in the first or second diagnostic fields, which may not always correlate with actual coding variability. This study demonstrates the limitation of that assumption, particularly in pediatric populations, where variability in provider coding practices and referral patterns may result in cancer diagnosis coding in less prominent diagnostic positions.

The additional descriptive analyses of this study examined whether chart review alone could have effectively identified primary malignant brain tumors. While chart review was essential for confirming diagnoses, it was the combination of systematic scanning of ICD-9 and ICD-10 codes within the first 10 diagnostic positions with chart reviews that enabled the identification of 16 additional cases of primary malignant brain tumors. This dual approach proved to be both efficient and feasible, especially compared to the impracticality of reviewing hundreds of thousands of charts manually (without utilizing any surveillance case definition).

All 16 missed cases were identified through outpatient encounters, however, which reveals specific limitations of the AFHSD surveillance case definition. Nine of those missed cases had a brain cancer ICD code in the first or second diagnostic position but failed to meet the required encounter frequency; 3 cases met the encounter frequency criterion but were too far apart (93 to 151 days); and 4 cases had the correct ICD codes, but not in the first or second diagnostic position. These findings highlight the rigidity of current criteria, which do not adequately account for variability in provider practices, particularly for pediatric populations.

This study evaluates only the PPV of the AFHSD surveillance case definition and does not include other metrics such as negative predictive value (NPV), sensitivity, specificity, or likelihood ratios. While these measures are important for a comprehensive understanding of case definition accuracy, calculating NPV was not feasible due to time and resource constraints. Conducting a sufficiently powered analysis would have required the chart review of over 2,000 cases to achieve approximately 80% power, which was beyond the scope of this study.

The findings from this study emphasize the need for continued refinement of surveillance case definitions for unique populations such as children. Potential solutions may include refining surveillance methods and modifying case definitions to incorporate greater flexibility for encounter timing and better account for variability in coding practices, as well as integrating data from specialized oncology centers and improving coordination of outpatient data. Future studies should explore these mechanisms to improve the accuracy and utility of surveillance case definitions in diverse populations and settings.

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References

1. Armed Forces Health Surveillance Division. Surveillance Case Definitions: Malignant Brain Tumor. Defense Health Agency, U.S. Dept. of Defense. Accessed Jul. 30, 2024. https://www.health.mil/reference-center/publications/2019/08/01/malignant-brain-tumor
2. Webber BJ, Rogers AE, Pathak SR, Robbins AS. Positive predictive value of an algorithm used for cancer surveillance in the US Armed Forces. *MSMR*. 2019;26(12):18-22.
3. U.S. Air Force School of Aerospace Medicine, Epidemiology Consult Service Division. Evaluation of Pediatric Brain Cancer Risk at Cannon Air Force Base. Memorandum for AFSOC/SG. U.S. Dept. of Defense. Feb. 12, 2024. Accessed Dec. 5, 2024. https://www.cannon.af.mil/portals/85/evaluation%20of%20pediatric%20brain%20cancer%20risk%20at%20cannon%20air%20force%20base.pdf
4. Central Brain Tumor Registry of the United States (CBTRUS). *CBTRUS Statistical Report: Primary Brain and Central Nervous System Tumors Diagnosed in the United States, 2016-2020*. Accessed Jul. 30, 2024. https://www.cbtrus.org
5. National Institute of Neurological Disorders and Stroke. Health Information: Brain and Spinal Cord Tumors. National Institutes of Health, U.S. Dept. of Health and Human Services. 2024. Accessed Jul. 30, 2024. https://www.ninds.nih.gov/health-information/disorders/brain-and-spinal-cord-tumors
6. American Academy of Family Physicians. Pediatric Cancer: Symptoms and Diagnosis. Accessed Jul. 30, 2024. https://www.aafp.org/family-physician/patient-care/clinical-recommendations/recommendations-by-topic/infant-and-child-clinical-recommendation-guidelines.html
7. St. Jude Children's Research Hospital. Together by St. Jude: Childhood Cancer Symptoms and Diagnosis. Accessed Nov. 27, 2024. https://together.stjude.org/en-us/conditions/cancers/diagnosing-childhood-cancer.html

Ovarian Dysfunction and Polycystic Ovary Syndrome in the U.S. Military Active Component, 2014–2023

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This retrospective cohort study examined ovarian dysfunction diagnosis incidence among female active component service members in the U.S. military from 2014 to 2023 using medical encounter data from the Defense Medical Surveillance System. Ovarian dysfunction diagnosis incidence gradually increased during this period, driven almost entirely by polycystic ovary syndrome (PCOS), of which the incidence increased from 32.0 cases per 10,000 person-years in 2014 to 60.3 cases per 10,000 person-years in 2023. Increases occurred among all demographic subcategories. This study also assessed independent association between ovarian dysfunction and socio-demographic and medical covariates, including COVID-19 infection and vaccination status. History of obesity had the strongest association with PCOS incidence, with an adjusted incident rate ratio (aIRR) of 2.5 and 95% confidence interval (CI) of 2.3 - 2.6. COVID-19 infection was modestly associated with PCOS incidence (aIRR 1.2; 95% CI, 1.1 - 1.3). COVID-19 vaccination status was not independently associated with increased PCOS incidence. A potential contributing factor of increased PCOS diagnosis incidence is that recent updates to the diagnostic criteria enabled more clinical and telehealth diagnoses. The increased incidence may also reflect the increasing rate of obesity and other related health burdens in the U.S. military.

What are the new findings?

Incidence of diagnosis of ovarian dysfunction, driven almost entirely by polycystic ovary syndrome, increased steadily among female active component service members from 2014 to 2023. This increase in incidence was observed in all demographic subgroups and had the strongest independent association with pre-existing obesity.

What is the impact on readiness and force health protection?

Health conditions due to ovarian dysfunction cause significant morbidity for female service members and contribute to reduced readiness and increased military health care spending. Increases in polycystic ovary syndrome in recent years could manifest in negative career impacts, including disqualification from certain military occupations and fewer service women able to meet retention standards.

Ovarian dysfunction is not a specific condition, but instead refers to a diagnostic code that may cover a range of conditions in which ovaries fail to function properly, often leading to hormonal imbalances, reduced ovulation, and associated physiological complications. These conditions include excess estrogen and androgen levels, primary ovarian insufficiency, and polycystic ovary syndrome (PCOS), among others.

PCOS is one of the most common endocrine and metabolic disorders affecting women of reproductive age, with an estimated worldwide prevalence ranging from 8% to 20%.[1,2] The 3 cardinal signs and symptoms of PCOS are 1) oligo-/amenorrhea, 2) hyperandrogenism, and 3) polycystic ovary morphology. The pathophysiology of PCOS is complex and remains incompletely understood, but environmental, genetic, and metabolic factors are assumed to be involved.[1,3,4] Associations have been found between PCOS and reproductive hormone dysregulation, obesity, insulin resistance, high calorie diets, smoking, suboptimal exercise, and genetics.[1] PCOS is a disqualifying condition for military recruitment,[5] and its sequelae make it difficult to maintain readiness standards for retention.

Ovarian dysfunction conditions, in particular PCOS, can cause a range of issues for the U.S. military, as these conditions can be associated excess weight gain, menstrual dysregulation, decreased fertility, cognitive and mood disturbances, and immune and endocrine dysfunction.[1,3,6] Excess weight gain can further place personnel at increased risk for musculoskeletal injuries, diabetes, heart disease, and sleep impairment.[7,8] These outcomes can directly affect fitness test and body composition pass rates, deployability, and personnel recruitment and retention.[5,7,8] Female active component service members (ACSMs) with PCOS have reported negative career impacts, particularly disqualification from career tracks such as aviation, submarines, diving, nuclear, and missile operation.[9] There are still gaps, however, in understanding of PCOS's full impacts on female ACSMs' careers and health. A 2022 meta-analysis estimated the financial burden of PCOS to the overall U.S. health care system at $8 billion a year,[10] which suggests that the condition may also present a significant cost burden to the Military Health System (MHS).

To further determine ovarian dysfunction trends in the U.S. military, this study's primary objective was to describe the incidence of ovarian dysfunction diagnoses among female ACSMs over a 10-year period, from 2014 to 2023. The study's secondary objective was to identify whether certain socio-demographic or medical variables, including COVID-19 infection history and vaccination status, had an independent association with ovarian dysfunction diagnosis incidence, after adjustment for covariates and potential confounders.

COVID-19 infection history and vaccination status were included in the analysis for several reasons. A sharp increase in the PCOS diagnosis incidence rate was observed from 2020 to 2021, coincident with the onset of the COVID-19 pandemic. Subsequently, several members of Congress expressed concern about a possible relationship between COVID-19 vaccination status and ovarian dysfunction in the U.S. military.[11] Existing literature suggests that people with existing PCOS may be more susceptible to severe COVID-19 infection, though studies to date do not identify either COVID-19 infection or vaccination as risk factors for ovarian dysfunction conditions.[12,13]

Methods

This study used a retrospective cohort study design to examine the incidence of ovarian dysfunction during the surveillance period of January 1, 2014 to December 31, 2023. The study population included all female service members from the active component of the U.S. Armed Forces including the Army, Navy, Marine Corps, Air Force, and Space Force. Individuals serving in the reserves, reservists on active duty, National Guard, and Coast Guard were not included. All data were drawn from the Defense Medical Surveillance System (DMSS), the central repository of medical data for service members. DMSS collects medical encounter data from both the MHS and civilian health care purchased through TRICARE.

Ovarian dysfunction cases were defined using International Classification of Diseases (ICD), 9th and 10th revisions, diagnostic codes. The selected ICD codes included estrogen excess, androgen excess, polycystic ovary syndrome, premature menopause, ovarian failure, and unspecified ovarian dysfunction **(Table 1)**. An individual was counted as a case if that person either 1) had at least 1 inpatient encounter with an ovarian dysfunction ICD code in the first or second diagnostic position or 2) had at least 2 outpatient encounters on separate dates with the same ovarian dysfunction code in any diagnostic position.

Socio-demographic and medical covariates examined in relation to ovarian dysfunction included age, race, rank or pay grade, occupation within the military, branch of service, prior COVID-19 infection, COVID-19 vaccination status, and obesity. COVID-19 cases were defined by either a medical encounter with ICD-10-CM code (U07.1) included in any diagnostic position, a positive PCR or antigen test, or a confirmed or probable reportable medical event for COVID-19 infection. COVID-19 vaccination status was defined as having received any dose of the COVID-19 vaccine. To measure both short- and any long-term risks, person-time was divided into 3 categories for COVID-19 infection: 1) never infected, 2) within 180 days after first infection, and 3) more than 180 days after first infection. COVID-19 vaccination status was stratified to the same 3 tiers. Obesity was defined as body mass index (BMI) of 30 or higher with height and weight measurements taken from an annual Periodic Health Assessment (PHA). In addition, individuals were classified as obese if they had a medical encounter with an obesity diagnosis in any diagnostic position.

TABLE 1. Ovarian Dysfunction ICD Codes

ICD-9	ICD-10
256.0. Hyper-estrongenism	E28.0. Estrogen excess
256.1. Ovarian hyperfunction	E28.1. Androgen excess
256.2. Post-ablative ovarian failure	E28.2. Polycystic ovary syndrome
256.31. Premature menopause	E28.310. Symptomatic premature menopause
256.39. Other ovarian failure	E28.319. Asymptomatic premature menopause
256.4. Polycystic ovaries	E28.39. Other primary ovarian failure
256.8. Other ovarian dysfunction	E.28.8. Other ovarian dysfunction
256.9. Unspecified ovarian dysfunction	E28.9. Ovarian dysfunction, unspecified

Abbreviations: ICD, International Classification of Diseases; ICD-9, International Classification of Diseases, 9th Revision; ICD-10, International Classification of Diseases, 10th Revision.

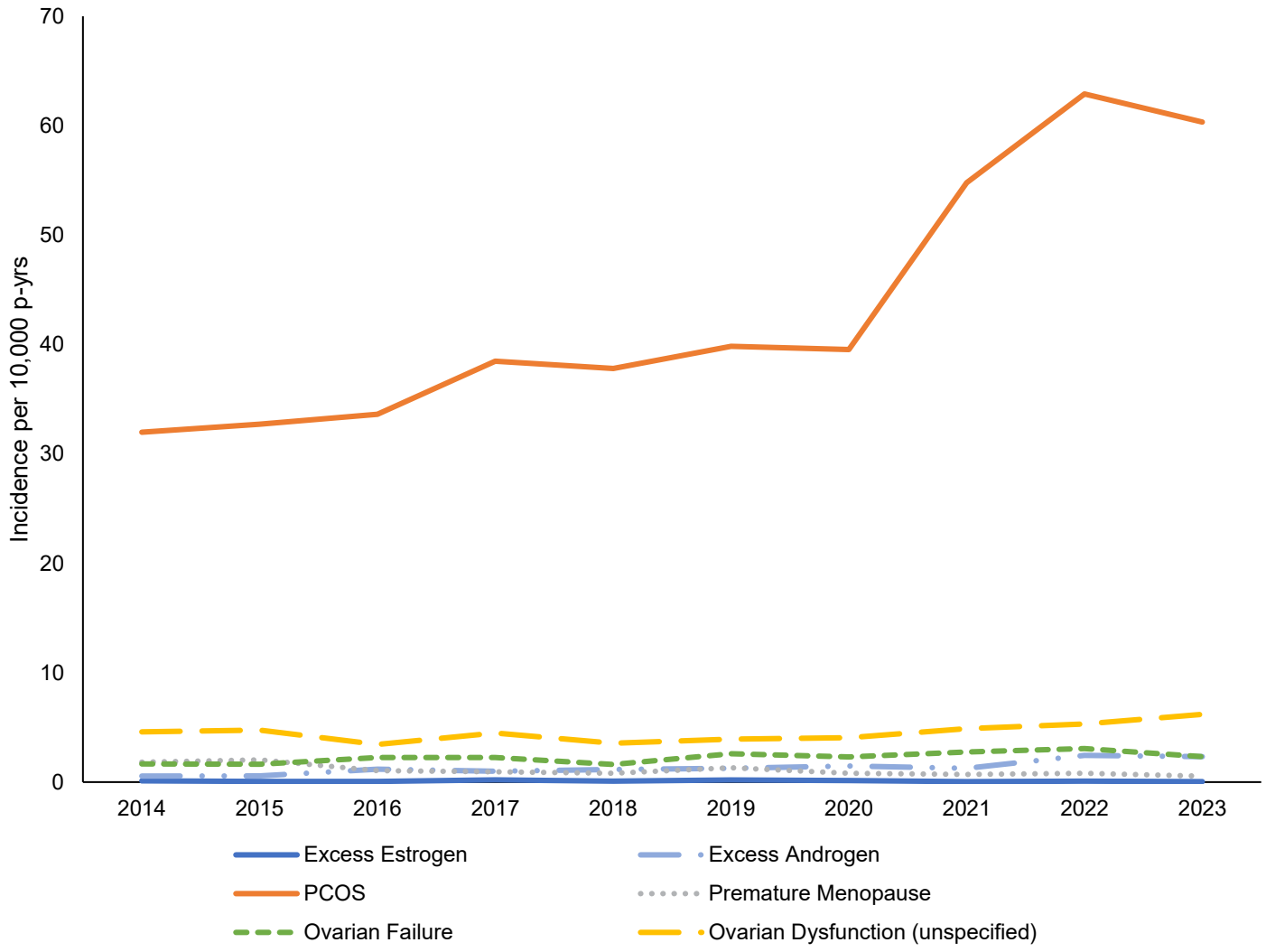
Person-time was collected from all female ACSMs each year, expressed as person-years (p-yrs). Individuals began contributing person-time on January 1, 2014 or when they entered military service, whichever occurred later. Person-time was censored upon an individual's first ovarian dysfunction diagnosis. Person-time was also censored upon an individual's departure from active component service or after December 31, 2023.

Statistical analysis for this study included descriptive statistics and calculation of incidence rates. Incidence rates were expressed as number of cases per 10,000 p-yrs and were calculated for each type of ovarian dysfunction, by year and by covariate. A Poisson regression model was used to identify independent associations of socio-demographic and medical covariates, including COVID-19 infection history and COVID-19 vaccination status, with incident ovarian dysfunction diagnosis, after adjusting for age, race, service branch, rank, occupation, and obesity. For the Poisson regression, the study population was restricted to 2021-2023, as this was the time during which the COVID-19 vaccine was available to service members.

Results

A gradual increase in ovarian dysfunction incidence was observed from 2014 to 2023, but PCOS was the only ovarian dysfunction condition that increased **(Figure)**. All other conditions did not demonstrate consistent significant change during that period of time. The PCOS incidence rate increased from 32.0 cases per 10,000 p-yrs in 2014 to 62.9 cases per 10,000 p-yrs in 2022. Notably, a sharp incidence increase occurred in the early 2020s, from 39.5 cases per 10,000 p-yrs in 2020 to 54.8 cases

FIGURE. Ovarian Dysfunction Diagnosis Incidence Rates Among Female Active-Component Service Members, U.S. Armed Forces, 2014–2023



Abbreviations: p-yrs, person-years; PCOS; Polycystic Ovary Syndrome.

per 10,000 p-yrs in 2021, and then to 62.9 cases per 10,000 p-yrs in 2022. The overall PCOS incidence in the active component from 2014 to 2023 was 43.6 cases per 10,000 p-yrs. Because PCOS incidence was responsible for the increase in ovarian dysfunction incidence during the surveillance period, the remainder of this study focuses on PCOS.

From 2014 through 2023, PCOS incidence increased in nearly all demographic subcategories (data not shown). The 25-29-year age group bore the highest incidence burden increase (from 47.3 cases per 10,000 p-yrs in 2014 to 82.8 cases per 10,000 p-yrs in 2023). A steady increase in incidence over 10 years was observed in all race categories, with no significant variation observed between categories. Gradual incidence increases were also observed for all branches of service, with the Air Force and Space Force experiencing the highest incidence burden increase (from 37.1 cases to 74.0 cases per 10,000 p-yrs over 10 years). All enlisted and junior officer pay grades demonstrated a steady increase over 10 years, with no significant variation observed between them. All military occupations also demonstrated a gradual increase, but with health care workers experiencing the highest incidence burden over 10 years (39.1 cases to 74.5 cases per 10,000 p-yrs). **Table 2** summarizes the total PCOS case count and incidence rate from 2014 to 2023 for all socio-demographic groups.

Results from the Poisson regression analysis **(Table 3)** indicate that history of obesity had the strongest association with PCOS, with an adjusted incidence rate ratio (aIRR) of 2.5 and 95% confidence interval (CI) of 2.3-2.6. Age categories of 25-29 years (aIRR 1.9; 95% CI, 1.6-2.3), 20-24 years (aIRR 1.9; 95% CI, 1.6-2.2), and 30-34 years (aIRR 1.3; 95% CI, 1.1-1.6) demonstrated the next highest PCOS associations. Service in the Air Force and Space Force (aIRR 1.3; 95% CI, 1.2-1.4), working in health care (aIRR 1.2; 95% CI, 1.1-1.4), and prior COVID-19 infection (aIRR 1.2; 95% CI, 1.1-1.3) all had modest though significant associations with increased PCOS incidence. No significant differences in PCOS incidence were observed based on race, rank, or COVID-19 vaccination status.

TABLE 2. Polycystic Ovarian Syndrome Case Count and Incidence Rates by Demographic Categories, 2014–2023

	Total Case Count	Rate[a]
Total	9,224	43.6
Race and ethnicity		
White, non-Hispanic	3,781	42.3
Black, non-Hispanic	2,425	46.4
Hispanic	1,826	45.8
Other	1,015	39.0
Unknown	177	44.7
Age, y		
< 20	334	19.8
20 - 24	3,521	50.2
25 - 29	3,120	60.1
30 - 34	1,499	45.2
35 - 39	607	27.4
40 - 44	117	11.0
45 - 49	22	5.0
50+	4	1.8
Service branch		
Army	2,784	40.0
Navy	2,705	42.9
Air Force / Space Force	3,338	52.6
Marine Corps	397	25.7
Rank		
Junior enlisted (E1-E4)	4,462	46.9
Senior enlisted (E5-E9)	3,390	45.2
Junior officer (O1-O3)	1,149	43.0
Senior officer (O4-O10)	196	15.3
Warrant officer (W)	27	16.1
Occupation		
Combat-specific	212	38.2
Armor / motor transport	233	35.1
Pilot / air crew	114	34.8
Repair / engineering	1,832	43.4
Communications / intelligence	3,035	45.1
Health care	2,066	52.6
Other	1,732	36.8

Abbreviations: y, years; p-yrs, person-years.
[a] Rate per 10,000 p-yrs.
Note: The most significant PCOS diagnosis incidence increases from 2014-2023 were observed among ages 20-39 years, Air Force / Space Force, enlisted and junior officer pay grades, and health care occupations. All race and ethnicity subcategories experienced increased incidence with no significant variation.

TABLE 3. Comparison of Ovarian Dysfunction Diagnosis Incidence by Socio-Demographic and Medical Factors

	aIRR	95% LL	95% UL	*P*-value
Race and ethnicity				
White, non-Hispanic	Reference	-	-	-
Black, non-Hispanic	1.0	0.9	1.1	0.8501
Hispanic	1.0	0.9	1.1	0.7782
Other	0.9	0.8	1.0	0.0342
Unknown	1.1	0.8	1.4	0.5893
Age, y				
< 20	Reference	-	-	-
20 - 24	1.9	1.6	2.2	< 0.0001
25 - 29	1.9	1.6	2.3	< 0.0001
30 - 34	1.3	1.1	1.6	0.0041
35 - 39	0.8	0.6	1.0	0.0197
40 +	0.3	0.2	0.4	< 0.0001
Service branch				
Army	Reference	-	-	-
Navy	1.0	1.0	1.1	0.3740
Air Force / Space Force	1.3	1.2	1.4	< 0.0001
Marine Corps	0.8	0.6	0.9	0.0007
Rank				
Enlisted	Reference	-	-	-
Officer	0.9	0.9	1.0	0.2148
Occupation				
Combat-specific	0.8	0.7	1.0	0.0866
Armor/motor transport	0.8	0.6	1.0	0.0187
Pilot / air crew	0.8	0.6	1.1	0.1367
Repair / engineering	0.9	0.8	1.0	0.0107
Communications / intelligence	Reference	-	-	-
Health care	1.2	1.1	1.4	< 0.0001
Other	0.8	0.8	0.9	< 0.0001
Prior diagnosis of COVID-19 infection				
Yes	1.2	1.1	1.3	< 0.0001
No	Reference	-	-	-
Prior COVID-19 vaccination				
Yes, within past 180 days	0.9	0.8	1.0	0.1578
Yes, not within past 180 days	1.0	1.0	1.1	0.3886
No, never	Reference	-	-	-
Prior obesity diagnosis, BMI				
Yes	2.5	2.3	2.6	< 0.0001
No	Reference	-	-	-

Abbreviations: aIRR, adjusted incidence rate ratio; LL, lower limit; UL, upper limit; y, years; COVID-19, coronavirus disease 2019; BMI, body mass index.
Note: Results of the Poisson regression model expressed as adjusted incident rate ratios with 95% confidence intervals. The model adjusted for race and ethnicity, age, service branch, rank or pay grade, occupation within the military, prior COVID-19 diagnosis, COVID-19 vaccination status, and history of obesity.

Discussion

PCOS incidence is not commonly calculated nor tracked annually within the U.S. population, which makes comparisons with the military population difficult. A 2023 retrospective cohort study conducted in the Kaiser Permanente Washington health care system that examined population-level PCOS incidence from 2006 to 2019, however, found an incidence rate of 42.5 cases per 10,000 p-yrs, which was similar to the 43.6 cases per 10,000 p-yrs incidence rate in female ACSMs.[2] Additionally, the Kaiser study found a gradual upward trend in PCOS incidence among younger patients that was proportionally similar to the upward trend observed in this study, over a similar time frame. PCOS prevalence is a more common metric in literature, but estimates vary greatly, commonly ranging from 7% to 20% of the reproductive age population.[1,2,14]

Multiple explanations for the increase in PCOS diagnoses among female ACSMs from 2014 to 2023 are possible. First, the 2018 International Evidence-based Guideline for the Assessment and Management of Polycystic Ovary Syndrome upheld and refined the 2003 Rotterdam diagnostic criteria for PCOS. Under the 2018 guideline, a PCOS diagnosis could potentially require minimal laboratory testing and no imaging.[15] A diagnosis could be made if a patient had irregular menstrual cycles or clinical evidence of androgen excess (acne, hirsutism, alopecia), or if other disorders affecting ovulation and hyperandrogenism had been excluded.[16,17] Irregular cycles are defined as an individual more than 3 years from menarche experiencing cycles less than 21 or more than 35 days apart, or less than 8 cycles per year. The 2018 guideline recommends testing for thyroid-stimulating hormone, prolactin, and follicle-stimulating hormone, at a minimum, to exclude other causes. A patient's clinical presentation may indicate a need to exclude additional conditions that could present with similar symptoms to PCOS, such as Cushing syndrome, congenital adrenal hyperplasia, or adrenal tumors.[15] While the 2018 guideline may have resulted in more clinical diagnoses, it does not necessarily explain the relatively sharp increase in PCOS diagnoses starting in 2020, as clinicians are not required to follow it before assigning a PCOS ICD code.

Another, potentially more plausible, explanation is that the COVID-19 pandemic saw an increased use of telehealth encounters during quarantine, less than 2 years after the 2018 guideline was released. This guideline update was more conducive to utilizing virtual health encounters as part of the PCOS diagnostic and management process, given the reduced emphasis on biochemical testing and imaging.[17-19] Future chart review studies could explore whether telehealth and a more clinical diagnostic approach played a role in the increased incidence of PCOS diagnoses among female ACSMs in the early 2020s. Such studies could help assess the clinical decision-making that led to a PCOS diagnosis code assignment for individual patients.

This study found a modest though significant association with COVID-19 infection and increased PCOS incidence (aIRR 1.2; 95% CI, 1.1 - 1.3). No significant association, however, was found between PCOS incidence and COVID-19 vaccination. Given the risk of severe COVID-19 infection among individuals with PCOS,[12,13] another hypothesis for the increase in PCOS cases among active component personnel in the early 2020s is that COVID-19 infections may have revealed previously subclinical cases of PCOS by placing those individuals under greater diagnostic scrutiny when they sought medical care.[7,13]

History of obesity had the strongest significant association with increased PCOS incidence after adjustment (aIRR 2.5; 95% CI, 2.3 - 2.6). Obese individuals are an established high-risk group for PCOS development. It has also been demonstrated that clinicians are significantly more likely to diagnose PCOS in overweight and obese patients, compared to their normal weight and underweight counterparts who may also meet criteria.[20] Existing PCOS cases are also aggravated by obesity, through worsening insulin resistance and increased androgen production.[1] Obesity prevalence has gradually risen in both the active duty military and U.S. civilian populations. The proportion of the active duty population that qualifies as obese more than doubled over 10 years, from 10.4% in 2012 to 21.6% in 2022, similar to the time frame of this study.[8] From 2018 to 2021, obesity prevalence among female active component personnel increased at twice the rate of their male counterparts.[21] Within this context, increasing PCOS incidence within the military may be more emblematic of the U.S. military's shifting health burdens, rather than the result of any one extrinsic cause. Factors such as sedentary occupations and lifestyle as well as high caloric diets have been implicated in the etiology of PCOS.[1] These factors are prevalent in the military and contribute to the increasing burden of obesity and related complications.[8,21]

One of this study's prominent limitations was that the outcome was operationalized through ICD codes, which may be subject to misclassification bias. For example, the 2023 Kaiser retrospective cohort study determined that 21% of PCOS ICD codes were either assigned without an adequate work-up, or to cases that were not PCOS.[2] Another hospital-based cohort study conducted over a 12-year period found that PCOS ICD code diagnoses gradually increased each year while the number of patients who potentially qualified for a PCOS diagnosis based on clinical presentation remained steady from year to year.[20] Our study did not have a parallel chart review component, so knowing whether PCOS diagnosis codes were assigned to female ACSMs in error or without an adequate work-up was beyond its scope. Another limitation was that there are a range of PCOS risk factors this study was unable to examine due to data unavailability, including sedentary lifestyle, high caloric diet, smoking, and family history of PCOS. Finally, the COVID-19 case burden is likely underestimated because data for at-home rapid antigen tests were not available.

Ovarian dysfunction trends among female active component personnel have increased over the past decade, driven almost entirely by increased incidence of PCOS. This study found minimal association between PCOS and COVID-19 infection history and no association between PCOS and COVID-19 vaccination. PCOS incidence was most strongly associated with a history of obesity, which may reflect

the changing health burdens in the U.S. military. Additional research is recommended to assess the proportion of PCOS ICD codes that are assigned accurately within the MHS, as this will help further characterize the PCOS burden among the female ACSM population. Further research could then explore the influence of different diagnostic approaches on PCOS incidence, the distribution of PCOS risk factors within the active component population, and the impact of increased PCOS incidence on military readiness.

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Disclaimer
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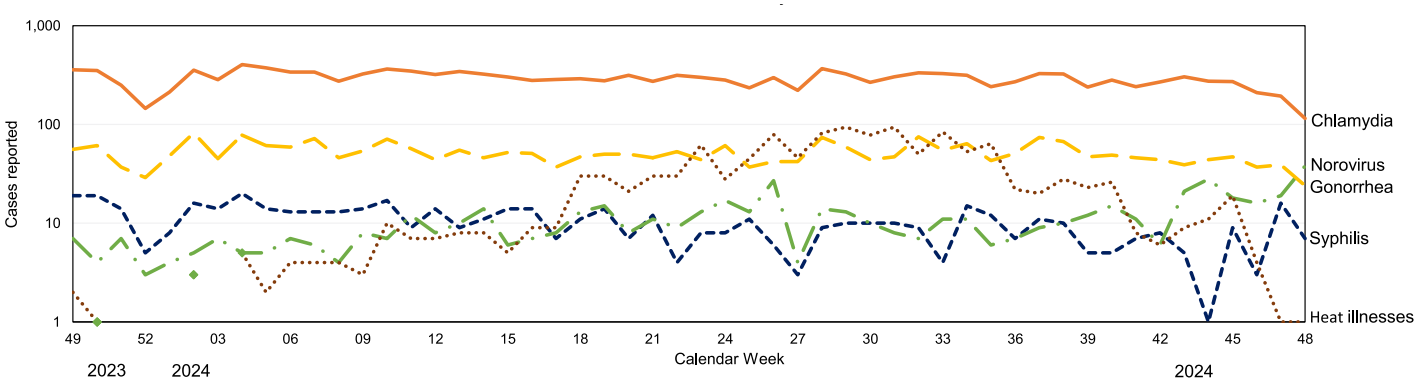
References

1. Singh S, Pal N, Shubham S, et al. Polycystic ovary syndrome: etiology, current management, and future therapeutics. *J Clin Med*. 2023;12(4):1454. doi:10.3390/jcm12041454
2. Yu O, Christ JP, Schulze-Rath R, et al. Incidence, prevalence, and trends in polycystic ovary syndrome diagnosis: a United States population-based study from 2006 to 2019. *Am J Obstet Gynecol*. 2023;229(1):39.e1-39.e12. doi:10.1016/j.ajog.2023.04.010
3. Fahs D, Salloum D, Nasrallah M, Ghazeeri G. Polycystic ovary syndrome: pathophysiology and controversies in diagnosis. *Diagnostics (Basel)*. 2023;13(9):1559. doi:10.3390/diagnostics13091559
4. Safiri S, Noori M, Nejadghaderi SA, et al. Prevalence, incidence and years lived with disability due to polycystic ovary syndrome in 204 countries and territories, 1990-2019. *Hum Reprod*. 2022;37(8):1919-1931. doi:10.1093/humrep/deac091
5. Office of the Under Secretary of Defense for Personnel and Readiness. DoDI 6130.03 Volume 1–Medical Standards for Military Service: Appointment, Enlistment, or Induction. U.S. Dept. of Defense. 2022. Accessed Sep. 24, 2024. https://www.esd.whs.mil/portals/54/documents/foid/reading%20room/personnel_related/15-f-1724_dodi_6130.3_v1.pdf
6. Dason ES, Koshkina O, Chan C, Sobel M. Diagnosis and management of polycystic ovarian syndrome. *CMAJ*. 2024;196(3):e85-e94. doi:10.1503/cmaj.231251
7. Hopkins D, Walker SC, Wilson C, et al. The experience of living with polycystic ovary syndrome in the military. *Mil Med*. 2024;189(1-2):188-197. doi:10.1093/milmed/usad241
8. Manning C. *Combating Military Obesity: Stigma's Persistent Impact on Operational Readiness, White Paper*. American Security Project. 2023. Accessed Jun. 4, 2024. https://www.americansecurityproject.org/costs-and-consequences-of-military-obesity
9. Hopkins D, Wilson C. Polycystic ovary syndrome in active-duty service women: a retrospective analysis. *Mil Med*. 2019;184(9-10):440-446. doi:10.1093/milmed/usz023
10. Riestenberg C, Jagasia A, Markovic D, Buyalos RP. Health care-related economic burden of polycystic ovary syndrome in the United States: pregnancy-related and long-term health consequences. *J Clin Endocrinol Metab*. 2022;107(2):575-585. doi:10.1210/clinem/dgab613
11. House Armed Services Committee. Statement of Lester Martinez-Lopez, MD, MPH, Assistant Secretary of Defense for Health Affairs, Office of the Secretary of Defense, U.S. Dept. of Defense, and Shauna Stahlman, PhD, MPH, Senior Epidemiologist, Epidemiology and Analysis Branch, Armed Forces Health Surveillance Division, Defense Health Agency, U.S. Dept. of Defense. MLP Hearing: Department of Defense Monitoring of COVID-19. Hearing Before the House Armed Services Committee. 118th Congress, 2nd Session. Mar. 7, 2024. Accessed May 22, 2024. https://armedservices.house.gov/hearings/mlp-hearing-department-defense-monitoring-covid-19
12. Pourmasumi S, Kounis NG, Naderi M, et al. Effects of COVID-19 infection and vaccination on the female reproductive system: a narrative review. *Balkan Med J*. 2023;40(3):153-164. doi:10.4274/balkanmedj.galenos.2023.2023-3-4
13. Samadian E, Aghcheli B, Gharaei R, Tabarraei A. A review on human reproductive systems encountering with the severe acute respiratory syndrome coronavirus 2 infection. *Int J Reprod Biomed*. 2023;21(1):1-16. doi:10.18502/ijrm.v21i1.12661
14. Teede HJ, Tay CT, Laven JJE, et al. Recommendations from the 2023 International Evidence-based Guideline for the assessment and management of polycystic ovary syndrome. *Eur J Endocrinol*. 2023;189(2):g43-g64. doi:10.1210/clinem/dgad463
15. Teede HJ, Misso ML, Costello MF, et al; National Medical and Research Council. *International Evidence-Based Guideline for the Assessment and Management of Polycystic Ovary Syndrome 2018*. Monash University;2018. Accessed Dec. 1, 2024. https://www.monash.edu/__data/assets/pdf_file/0004/1412644/PCOS_Evidence-Based-Guidelines_20181009.pdf
16. Teede HJ, Misso ML, Costello MF, et al. Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome. *Fertil Steril*. 2018;110(3):364-379. doi:10.1016/j.fertnstert.2018.05.004
17. Christ JP, Cedars MI. Current guidelines for diagnosing PCOS. *Diagnostics (Basel)*. 2023;13(6):1113. doi:10.3390/diagnostics13061113
18. Teede H, Misso ML, Costello MF, et al. Recommendations from the International Evidence-based Guideline for the assessment and management of polycystic ovary syndrome. *Fertil Steril*. 2018;110(3):364-379. doi:10.1016/j.fertnstert.2018.05.004
19. Dunne C. Diagnosis and treatment of polycystic ovary syndrome using virtual health. *This Changed My Practice (TCMP) by UBC CPD*. Faculty of Medicine, University of British Columbia;2022. Accessed Jun. 12, 2024. https://thischangedmypractice.com/diagnosis-and-treatment-pcos-using-virtual-health
20. Silva EL, Lane KJ, Cheng JJ, et al. Polycystic ovary syndrome underdiagnosis patterns by individual-level and spatial social vulnerability measures. *J Clin Endocrinol Metab*. 2024:dgae705. doi:10.1210/clinem/dgae705
21. Stiegmann RA, Payne CB, Kiel MA, Stahlman SL. Increased prevalence of overweight and obesity and incidence of prediabetes and type 2 diabetes during the COVID-19 pandemic, active component service members, U.S. Armed Forces, 2018 to 2021. *MSMR*. 2023;30(1):11-18.

Reportable Medical Events at Military Health System Facilities Through Week 48, Ending November 30, 2024

Idalia Aguirre, MPH; Matthew W. R. Allman, MPH; Anthony R. Marquez, MPH; Katherine S. Kotas, MPH

TOP 5 REPORTABLE MEDICAL EVENTS BY CALENDAR WEEK, ACTIVE COMPONENT (OCTOBER 1, 2023 - NOVEMBER 30, 2024)



Abbreviation: RMEs, reportable medical events.

[a]Cases are shown on a logarithmic scale.

Note: There were 0 heat illness cases in the following weeks: 51-52 in 2023 and weeks 1 and 3 in 2024. Markers added to represent instances of heat illnesses that were not visible on the logarithmic scale graph.

Reportable Medical Events (RMEs) are documented in the Disease Reporting System internet (DRSi) by health care providers and public health officials throughout the Military Health System (MHS) for monitoring, controlling, and preventing the occurrence and spread of diseases of public health interest or readiness importance. These reports are reviewed by each service's public health surveillance hub. The DRSi collects reports on over 70 different RMEs, including infectious and non-infectious conditions, outbreak reports, STI risk surveys, and tuberculosis contact investigation reports. A complete list of RMEs is available in the *2022 Armed Forces Reportable Medical Events Guidelines and Case Definitions*.[1] Data reported in these tables are considered provisional and do not represent conclusive evidence until case reports are fully validated.

Total active component cases reported per week are displayed for the top 5 RMEs for the previous year. Each month, the graph is updated with the top 5 RMEs, and is presented with the current month's (November 2024) top 5 RMEs, which may differ from previous months. COVID-19 is excluded from these graphs due to changes in reporting and case definition updates in 2023.

For questions about this report, please contact the Disease Epidemiology Branch at the Defense Centers for Public Health–Aberdeen. Email: dha.apg.pub-health-a.mbx.disease-epidemiologyprogram13@health.mil

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References

1. Armed Forces Health Surveillance Division. Armed Forces Reportable Medical Events. Accessed Feb. 28, 2024. https://health.mil/reference-center/publications/2022/11/01/armed-forces-reportable-medical-events-guidelines
2. Defense Manpower Data Center. Department of Defense Active Duty Military Personnel by Rank/Grade of Service. Accessed Feb. 28, 2024. https://dwp.dmdc.osd.mil/dwp/app/dod-data-reports/workforce-reports
3. Defense Manpower Data Center. Armed Forces Strength Figures for January 31, 2023. Accessed Feb. 28, 2024. https://dwp.dmdc.osd.mil/dwp/app/dod-data-reports/workforce-reports
4. Navy Medicine. Surveillance and Reporting Tools–DRSI: Disease Reporting System Internet. Accessed Feb. 28, 2024. https://www.med.navy.mil/navy-marine-corps-public-health-center/preventive-medicine/program-and-policy-support/disease-surveillance/drsi

TABLE. Reportable Medical Events, Military Health System Facilities, Week Ending November 30, 2024 (Week 48)[a]

Reportable Medical Event[b]	Active Component[c]					MHS Beneficiaries[d]
	October 2024	November 2024	YTD 2024	YTD 2023	Total 2023	November 2024
	No.	No.	No.	No.	No.	No.
Amebiasis	2	2	13	14	15	1
Arboviral diseases, neuroinvasive and non-neuroinvasive	0	0	3	2	2	0
Brucellosis	0	0	1	0	0	0
COVID-19-associated hospitalization and death[e]	0	1	40	100	113	15
Campylobacteriosis	14	20	294	257	270	15
Chikungunya virus disease	0	0	0	2	2	0
Chlamydia trachomatis	1,260	840	14,077	16,322	17,510	114
Cholera	1	0	3	4	4	0
Coccidioidomycosis	0	1	43	30	36	1
Cold weather injury[f]	3	17	155	126	152	N/A
Cryptosporidiosis	8	1	79	61	67	0
Cyclosporiasis	1	0	11	15	15	0
Dengue virus infection	0	1	12	7	7	0
E. coli, Shiga toxin-producing	3	8	78	64	69	2
Ehrlichiosis / anaplasmosis	0	0	2	28	28	0
Giardiasis	11	4	94	74	78	2
Gonorrhea	205	153	2,499	2,561	2,763	17
Haemophilus influenzae, invasive	0	0	3	1	1	1
Hantavirus disease	0	0	0	1	2	0
Heat illness[f]	55	27	1,266	1,250	1,253	N/A
Hepatitis A	1	0	6	7	7	0
Hepatitis B, acute and chronic	4	5	96	141	155	5
Hepatitis C, acute and chronic	0	0	28	48	52	6
Influenza-associated hospitalization[g]	5	0	45	21	29	5
Lead poisoning, pediatric[h]	N/A	N/A	N/A	N/A	N/A	1
Legionellosis	0	0	4	5	5	0
Leishmaniasis	0	0	0	1	1	0
Leprosy	0	0	0	2	2	0
Leptospirosis	0	0	0	4	4	0
Lyme disease	6	7	99	67	70	4
Malaria	2	0	18	26	28	0
Meningococcal disease	1	0	1	2	4	0
Mpox	1	1	13	4	5	0
Norovirus	59	107	543	396	420	57
Pertussis	3	2	25	13	15	15
Post-exposure prophylaxis against Rabies	37	40	545	557	598	24
Q fever	0	0	2	2	2	0
Rubella	0	0	0	2	2	0
Salmonellosis	18	15	147	119	129	20
Schistosomiasis	0	1	1	0	0	0
Shigellosis	3	1	46	59	59	1
Spotted Fever Rickettsiosis	1	0	20	31	31	0
Syphilis (all)[i]	24	35	477	871	931	6
Toxic shock syndrome	0	0	2	1	2	0
Trypanosomiasis	0	1	3	1	1	0
Tuberculosis	0	0	3	11	11	0
Tularemia	0	0	1	1	1	0
Typhoid fever	0	0	1	2	2	0
Typhus fever	0	1	2	3	3	0
Varicella	0	1	13	12	13	4
Zika virus infection	0	0	1	0	0	0
Total case counts	1,728	1,292	20,815	23,328	24,969	316

Abbreviations: MHS, Military Health System; YTD, year-to-date; no., number; *E., Escherichia*; N/A, not applicable.

[a] RMEs reported through the DRSi as of Dec. 4, 2024 are included in this report. RMEs were classified by date of diagnosis or, where unavailable, date of onset. Monthly comparisons are displayed for the period of Oct. 1, 2024–Oct. 31, 2024 and Nov. 1, 2024–Nov. 30, 2024. YTD comparison is displayed for the period of Jan. 1, 2024–Nov. 30, 2024 for MHS facilities. Previous year counts are provided as the following: previous YTD, Jan. 1, 2023-Nov. 30, 2023; total 2023, Jan. 1, 2023–Dec. 31, 2023.

[b] RME categories with 0 reported cases among active component service members and MHS beneficiaries for the time periods covered were not included in this report.

[c] Services included in this report include the Army, Navy, Air Force, Marine Corps, Coast Guard, and Space Force, including personnel classified as Active Duty, Cadet, Midshipman, or Recruit in DRSi.

[d] Beneficiaries included the following: individuals classified as Retired and Family Members (including Spouse, Child, Other, Unknown). National Guard, Reservists, civilians, contractors, and foreign nationals were excluded from these counts.

[e] Only cases reported after case definition update on May 4, 2023. Includes only cases resulting in hospitalization or death. Does not include cases of hospitalization or death reported under the previous COVID-19 case definition.

[f] Only reportable for service members.

[g] Influenza-associated hospitalization is reportable only for individuals under 65 years of age.

[h] Pediatric lead poisoning is reportable only for children aged 6 years or younger.

[i] The observed drop in syphilis cases from 2023 to 2024 may be due, in part, to an updated case validation process that began Jan. 2024.

From the Editor's Desk

MSMR 2024 Successes and Plans for 2025

Thank you for being one of our many *MSMR* readers. While we are grateful for invaluable contributions by individuals and affiliated organizations this year, it is our readers whom we consider foremost while assembling each issue of *MSMR*. As part of the Armed Forces Health Surveillance Division (AFHSD), within the Public Health Directorate (PHD) of the Defense Health Agency (DHA), *MSMR* offers a forum for peer-reviewed public health reports that are disseminated on a variety of digital platforms: published online at health.mil, the official website of the Military Health System (MHS), in addition to indexing on PubMed and full text archiving on PubMed Central (PMC). I would like to take this opportunity to enumerate some of our successes in 2024 and preview our plans for 2025.

Page views for *MSMR* articles on the health.mil webpage more than doubled in 2024. *MSMR* significantly increased readership and downloads of full length articles on a variety of military health-related topics. The most widely read articles in 2024 on our webpage included topics historically under-represented in *MSMR*, namely surveillance of pharmacy prescription practices and service member mortality statistics. Three full reports published in 2024 garnered over 11,000 page views in total: an article describing weight loss medication prescription prevalence, a report on U.S. Army mortality surveillance, and a review of ivermectin prescription fill rates among service members during the COVID-19 pandemic.

In January, *MSMR* began archiving full text versions of published reports on PMC, the companion database to PubMed that enables readers to view, read, as well as download full text of articles indexed in PubMed. At the time of writing, nearly 7,500 total full text articles or PDFs of *MSMR* articles published in 2024 had been viewed or downloaded on PMC. We anticipate that this additional archival process of our content will continue to expand our readership to a broader public health community in 2025 and the years to come. The total webpage views from health.mil in 2024 exceeded these PMC views by 3 times, indicating that the majority of *MSMR* readership still originates from readers directly accessing the MHS webpage, or via PubMed.

PubMed allows its users to click on a link to the *MSMR* health.mil webpage, and PubMed 2014 statistics show that "linkouts" or clicks from PubMed to health.mil increased as well, significantly: by 26%, within the last year alone. *MSMR* content has been indexed on PubMed, the National Center for Biotechnology Information website, since 2011.

Our reach and readership are expanding as the appetite for high quality, evidenced-based military health-specific topics continues to grow. The Department of Defense public health community is focused on collecting, publishing, and applying the increasing knowledge base to positively influence health awareness and outcomes. In 2025, *MSMR* will continue its mission to publish descriptive epidemiologic articles using relevant data on topics that are vital to the health and safety of the U.S. Armed Forces.

Our plans for 2025 are robust. We will celebrate the 30th anniversary of *MSMR* in April 2025. We are coordinating with authors who are well-versed in the long history of U.S. military public health as well as the more recent past, namely the 30 years *MSMR* has been reporting on public health topics. Our April issue will feature articles that offer a comprehensive review of the long and storied military public health experience in the U.S. and articulate the supporting role *MSMR* has played in this domain over the past 30 years.

We are also collecting and continuing to solicit manuscripts for a special issue focusing on the unique and important concerns related to military women's health. This women's health issue is planned for May 2025, to coincide with National Women's Health Week, observed this May 12th through 16th. Our September 2024 issue featured a call for papers on military women's heath that has received a substantial number of page views on health.mil, a harbinger of the interest this topic deserves and receives.

In my first From the Editor's Desk letter, published in January 2024, I articulated the *MSMR* mission, to which our dedication remains firm and unchanged: "In the most recent Armed Forces Health Surveillance Division (AFHSD) Annual Report, *MSMR* is referred to as the 'premier medical peer-reviewed journal published by the AFHSD and DHA, which provides evidence-based estimates of the incidence, distribution, impact and trends of illness and injury among U.S. military service members and associated populations'." As we enter our 31st year of publishing, the *MSMR* staff is honored to pick up and carry *MSMR*'s distinguished legacy of excellence and professional rigor even further.

Our increased readership and article downloads in 2024 resulted not only from the hard work of *MSMR* staff but, of course, because of the excellent manuscripts we received from investigators and researchers, not only from DHA organizations but civilian and international contributors as well. *MSMR* has enlarged its outreach to areas outside DHA PHD by collaborating with DHA Medical Affairs, Communications, and Public Affairs in a sustained effort to share the insights provided by the substantial medical data available and enhance the reach of dissemination more broadly. We have complied a list of all our contributing authors for 2024 in a concluding feature in this month's issue that recognizes this critical resource, with our sincerest gratitude.

MSMR's role, within and supporting the overall mission of AFHSD, PHD, and DHA, remains vital. The need for appropriate database utilization, information review, and methodologically valid analysis remains the 'gold standard' of epidemiological surveillance and medical knowledge development. At *MSMR*, we continue to strive for timeliness with careful deliberation, relevance with objectivity, and scientific validity focused on readiness and force health protection. *MSMR* continues to be vigilant and undaunted by the continued high stakes role of public health, but the successes of 2024 positions us well to continue to serve "those who serve" in 2025.

Very Respectfully,
Robert Johnson, MD, MPH, MBA
Col (ret) USAF
Editor-in-Chief
Medical Surveillance Monthly Report

Thank You to Our 2024 Authors and Contributors

The Editor-in-Chief of *MSMR*, its contributing editors, and production staff would each like to extend appreciation and gratitude to the authors who submitted manuscripts to *MSMR* during 2024. The resultant published articles represent dozens or more of hours of diligent research, exacting analysis, and meticulous organization by these authors, who then worked collaboratively with *MSMR*'s editors to refine each manuscript for publishing. Without their dedication and sacrifice of time and effort, *MSMR* could not provide important monthly, evidence-based reports of the incidence, distribution, impact, and trends of health-related conditions among service members.

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