JAMA Network Open

Original Investigation | Neurology

Mild Traumatic Brain Injury and Subsequent Musculoskeletal Injury in US Service Members

Alexander Ivan B. Posis, PhD, MPH; Amy Silder, PhD; James M. Zouris, MS; Andrew J. MacGregor, PhD, MPH; John J. Fraser, DPT, PhD; Daniel J. Crouch, PhD, MPH; Pinata H. Sessoms, PhD

Abstract

IMPORTANCE Mild traumatic brain injury (mTBI) is associated with greater risk of musculoskeletal injury (MSKI). However, it is unclear whether mTBI is associated with risk of subsequent MSKI among US service members (SMs) with extended follow-up and whether this varies between male and female individuals.

OBJECTIVE To test the association of mTBI with subsequent MSKI in a large study population of SMs with extended follow-up.

DESIGN, SETTING, AND PARTICIPANTS This cohort study included SMs with mTBI and propensity score–matched controls who joined between 2016 and 2020 across all branches of the US military and had medical record data until 2023. Data were analyzed from December 2024 to October 2025.

EXPOSURE Medical record–derived mTBI.

MAIN OUTCOME AND MEASURES mTBIs and MSKI events were identified using *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* codes. To test associations of mTBI with subsequent overall MSKI, Cox proportional hazards and Aalen additive hazards models were fit to estimate relative and absolute effect sizes, respectively. Testing was completed for moderation by sex. All models were adjusted for demographic and military-relevant characteristics.

RESULTS The mean (SD) age of the 26 784 participants (13 392 with mTBI and 13 392 controls without mTBI) was 20.0 (2.8) years, and 4585 (17.1%) were female. During 34 156 person-years of follow-up, there were 14 330 MSKI events. Compared with no mTBI, mTBI was associated with a greater hazard of subsequent MSKI (hazard ratio [HR], 2.24; 95% CI, 2.16-2.32). On the absolute scale, mTBI, compared with no mTBI, was associated with an additional 258 MSKI events per 100 000 person-days (Aalen additive hazard = 2.58×10^{-3}; SE, 1.17×10^{-6}). Although there was no significant interaction in associations of mTBI with subsequent MSKI by sex (*P* for interaction = .37), mTBI was associated with greater hazard of MSKI in models among female SMs only (HR, 2.28; 95% CI, 1.92-2.70), and in models among male SMs only (HR, 2.20; 95% CI, 2.11-2.29).

CONCLUSIONS AND RELEVANCE In this cohort study of US SMs, mTBI was associated with greater hazard of subsequent MSKI on the relative and absolute scales. Female SMs had a greater hazard of MSKI, but there was no significant moderation by sex for associations between mTBI and MSKI. Findings can inform patient counseling on MSKI risk following mTBI.

JAMA Network Open. 2026;9(6):e2619409. doi:10.1001/jamanetworkopen.2026.19409

Key Points

Question Is mild traumatic brain injury (mTBI) associated with a greater hazard of subsequent musculoskeletal injury (MSKI) among US service members?

Findings In this cohort study of 26 784 service members, mTBI was associated with a 2.24 times greater hazard of MSKI compared with no mTBI.

Meaning These findings highlight the importance of focusing on MSKI risk following an mTBI event in US service members.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

Introduction

Musculoskeletal injuries (MSKIs) are a leading cause of morbidity and disability, especially among US service members.[1-6] They are responsible for the greatest health care burden in the US military and can negatively impact long-term health trajectories.[2] Military training, operations, occupational exposures, and environmental hazards place high demands on the musculoskeletal system, resulting in high injury rates across all military service branches.[1] According to a US Army War College report,[1] MSKI is the primary reason for nondeployment in approximately 45% of all medically related cases and 65% of medically nondeployable soldiers in 2017.[1] Therefore, it is crucial to assess MSKI risk factors and identify groups at greater injury risk to inform targeted prevention efforts. Since female sex and history of mTBI have been identified as important risk factors for MSKI,[7-9] the interaction of these factors may be relevant.

Approximately 421 760 mild traumatic brain injuries (mTBIs) have occurred in the US military between 2000 and 2024.[10] Individuals with mTBI can exhibit a wide range of impairments, including visual, vestibular, motor, and cognitive deficits.[11] These impairments affect decision-making,[12,13] balance, coordination, processing, and response to perturbation and hazards during military activities, especially in highly variable and dangerous environments; one or more of these impairments may lead to a subsequent MSKI.[9,14]

While the interaction of sex and mTBI exposure on MSKI in military service members is understudied, there is evidence from studies of collegiate athletes that supports this supposition. In a study of 468 collegiate student-athletes, female students with a history of concussion had 2.54 times higher odds of subsequent ankle injury and 1.88 higher odds of knee injury compared with their male counterparts.[15] Notably, there were no significant cross-sectional associations between mTBI and MSKI history observed in male student-athletes. In a meta-analysis of 4 studies investigating the interaction of sex and mTBI on subsequent MSKI in collegiate athletics, female athletes with a history of concussion had 2.23 times (95% CI, 1.40-3.57; I^2 = 0%) higher odds of MSKI compared with nonconcussed female athletes, whereas male athletes with concussion had 2.06 (95% CI, 1.26-3.37; I^2 = 62.9%) times the odds of MSKI.[8] While sex-related differences in mTBI and subsequent MSKI rates have been identified in collegiate and nonveteran athletes, it is unclear whether sex is a salient factor in subsequent MSKI following mTBI in US service members.[7,16,17]

The objective of this study was to test the association of mTBI with subsequent MSKI in a large study population of US service members with extended follow-up. We also tested effect measure modification by sex in these associations. Due to the increased number and evolving roles of female service members serving in the military,[18] evaluation of how the female sex and mTBI exposure interaction on subsequent MSKI was warranted.

Methods

Study Design

A matched population-based retrospective cohort study of US military service members was performed. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline. The study protocol was approved by the Naval Health Research Center institutional review board, which issued a waiver of informed consent for this study in accordance with 32 CFR §219.116(f) in that this study is classified as minimal risk.

Study Population

The study population included female and male US active-duty service members from the Air Force, Army, Marine Corps, and Navy of all ages, with accession dates from 2016 to 2020. This study used data from the Military Health System and Military Data Repository (MDR). We did not include data prior to 2016, given the transition from *International Classification of Diseases, Ninth Revision* (*ICD-9*) to *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*

(*ICD-10*) coding, which may yield differential injury classification.[19] Injury data from the MDR were considered up until 2023. The full cohort flow diagram is shown in **Figure 1**. We identified 781 444 active-duty military accessions from 2016 to 2020 without prior MSKI, more than 1 sex and/or service branch reported in the MDR, and sufficient time-to-event data. We further excluded 3631 participants who had a TBI severity greater than mild and 163 with limited or missing demographic data. To account for reverse causality, we excluded 13 608 participants with less than 1 month of follow-up from their accession date or time of mTBI. This yielded a potential pool of 764 042 participants.

For our matched analysis, we identified service members with mTBI and used 1-to-1 nearest neighbor matching without replacement. The caliper was 0.2 SD of the logit of the propensity score.[20] Matching was based on propensity scores estimated via a logistic regression model for the probability of mTBI, conditional on age, entry year, rank, occupation, race and ethnicity, and service branch. Sex was not included in the propensity score model because it was the effect modifier of interest. To assess covariate balance, we estimated mean differences in covariates by mTBI status; all differences were below 0.1, suggesting good balance (eFigure 1 in Supplement 1).[21] We defined baseline for mTBI cases as the time of injury and for controls as the time of matching to mTBI case.

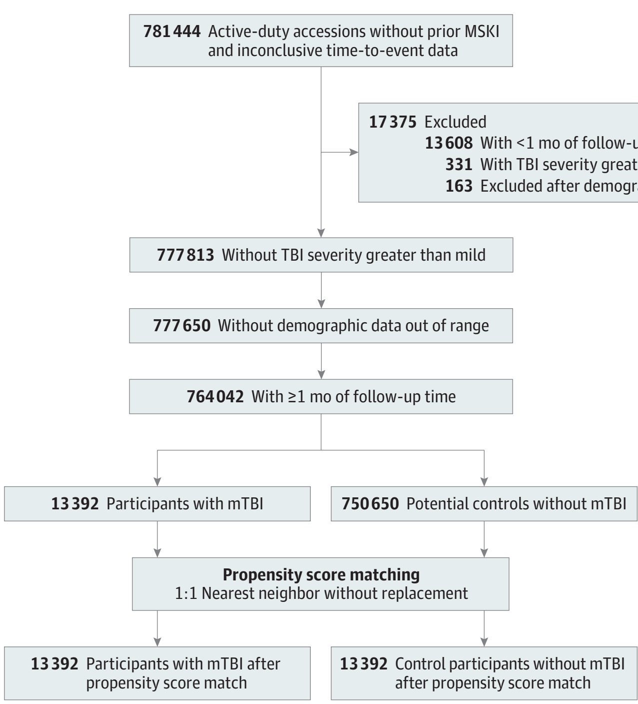
Exposure Variable: mTBI

We identified mTBI events using *ICD-10* codes defined by the Armed Forces Health Surveillance Division (eTable 1 in Supplement 1).[22] For this study, an mTBI was considered the first mTBI event (ie, a single encounter code) after the service member's accession date. We focused on the first mTBI following accession to not confound the outcomes that may be due to a prior injury.

Outcome Variable: MSKI History

We classified MSKI using the Neuromusculoskeletal Epidemiological Outcome (NEO) matrix; details have been described elsewhere.[13] The NEO matrix identifies MSKIs by anatomical complex and primary tissue type affected using *International Classification of Functioning, Disability and Health*

Figure 1. Flow Diagram of Propensity Score–Matched Retrospective Cohort Study



MSKI indicates musculoskeletal injury; mTBI, mild traumatic brain injury; TBI, traumatic brain injury.

and *ICD-10* codes (eTable 6 in Supplement 2). Importantly, the NEO matrix allows for the identification of repetitive microtraumatic injuries, which may not be identifiable in the Barell Injury Diagnosis Matrix.[23] For this study, an MSKI was considered the first MSKI event after the service member's mTBI, or matching date, whichever occurred first.

Covariates

We considered several potentially confounding covariates identified using the MDR database that may affect both MSKI and mTBI, which included age at accession (years), sex (female or male), race and ethnicity (American Indian or Alaska Native or other or unknown, Asian, Black, Hispanic or Latino, or White), occupation (noncombat or combat), rank (enlisted or officer), and service branch (Air Force, Army, Marine Corps, or Navy). Data on race and ethnicity were obtained from the Military Health System and MDR and are included here because of potential differences in either injury.

Statistical Analysis

We described participants by mTBI status, using means and SD for continuous variables or counts and percentages for categorical variables. To visualize MSKI incidence, we estimated cumulative incidence by mTBI and non-mTBI groups to account for competing events.

To estimate effect sizes on the relative scale, we used a cause-specific multivariable Cox proportional hazards model to estimate the association of mTBI with subsequent MSKI. Outcomes included days to MSKI, loss to follow-up, or end of the follow-up period in 2023, whichever event occurred first. Death and loss to follow-up were treated as censoring events. The model adjusted for age, sex, race and ethnicity, occupation, rank, and service branch. We tested the proportional hazards assumption using Schoenfeld residuals given sensitivity to minor deviations with a large sample size; no major deviations were apparent except for rank, which was treated as a stratification variable (eFigure 2 in Supplement 1).[24] To estimate the difference in hazard rates, we fit an Aalen additive hazards model to estimate the relative absolute risk of MSKI. Aalen additive models generate robust estimates under nonproportional hazards and time-varying covariates. For all models, person-days was the underlying timescale, and SEs were estimated using a robust sandwich-type variance estimator to account for clustering between matched pairs.[25]

To assess moderation by sex, we used likelihood ratio tests comparing fully adjusted models with and without an mTBI-by-sex interaction term. Then, we compared estimates of the association of mTBI with subsequent MSKI in sex-stratified models. Sex-stratified Cox proportional hazards models included stratified covariates to improve model fit. Describing event rates by group and testing interactions is consistent with rigorous methods for testing effect measure modification.[26]

In a sensitivity analysis, we assessed whether associations were pronounced closer to the point of mTBI by repeating our main analysis, restricted to a 1-year follow-up period. We tested potential confounding by index trauma by repeating analyses with 3-month and 6-month washout periods. Finally, we repeated primary models after additionally matching on sex.

All analyses were performed in SAS Enterprise Guide 8.3 (SAS Institute, Inc) and R version 4.5.0 (R Project for Statistical Computing). Data were analyzed from December 2024 to October 2025, using the following packages: cobalt for assessing covariate balance,[27] and survival for Cox proportional hazards and Aalen additive models.[28] Two-sided $P < .05$ was considered statistically significant.

Results

Participant Characteristics

The overall mean (SD) age of the 26 784 service members in this study was 20.0 (2.8) years, and 4585 (17.1%) were female, 1370 (5.1%) were officers, and 6667 (24.9%) had a combat-related occupation. Reported race and ethnicity was 734 (2.7%) American Indian or Alaska Native and/or other or unknown, 1337 (5.0%) Asian or Pacific Islander, 4318 (16.1%) Black, 4724 (17.6%) Hispanic or Latino, and 15 671 (58.5%) White. Most participants were in the Army (13 667 [51.0%]). Compared with the 13 392 matched controls without mTBI, the 13 392 with mTBI had shorter follow-up time in the study period (mean [SD], 358 [358] vs 574 [483] days) and a greater proportion were female (3045 [22.7%] vs 1540 [11.5%]) (**Table**). Those with MSKI compared with no MSKI had shorter average follow-up (332 vs 620 days), had a greater proportion female (2898 [20.2%] vs 1687 [13.5%]), and greater proportion in the Army (7841 [54.7%] vs 5826 [46.8%]) (eTable 2 in Supplement 1).

Association of mTBI With Subsequent MSKI

Over 34 156 person-years of follow-up (mean [SD], 1.28 [1.23] years), there were 14 330 MSKI events (rate, 4195 per 1000 person years) (**Figure 2**). In the matched analysis, mTBI was associated with more than 2 times (hazard ratio [HR], 2.24; 95% CI, 2.16-2.32) (**Figure 3**) greater hazard of MSKI in fully adjusted models. On the absolute scale, compared with no mTBI, mTBI was associated with an additional 258 MSKI events per 100 000 persons per day (Aalen estimate, 2.58×10^{-3}; SE, 1.17×10^{-6}) or an additional 942 MSKIs per 1000 person-years. In other words, mTBI was associated with an excess hazard of MSKI on both the additive and relative scales. Results were similar after restricting analyses to the first year of follow-up, using 3-month and 6-month washout periods, and additionally matching by sex (eTables 3-5 and eFigure 3 in Supplement 1).

Moderation by Sex in the Association of mTBI With Subsequent MSKI

Female service members had a greater crude rate of MSKI (5504 per 1000 person-years) compared with male service members (3957 per 1000 person-years). In the fully adjusted Cox proportional hazards model, female service members had a 35% greater hazard of MSKI vs male service members (HR, 1.35; 95% CI, 1.26-1.44) after controlling for mTBI, age, rank, occupation, race and ethnicity, and service branch. In the Aalen additive model, female service members, compared with male service

Table. Characteristics of Match Cohort, by mTBI Status

Characteristic	Participants, No. (%)	
	No mTBI (n = 13 392)	mTBI (n = 13 392)
Follow-up time, d		
Mean (SD)	574 (483)	358 (385)
Median (IQR)	441 (199-821)	229 (86-493)
Age, mean (SD), y	20.0 (2.7)	20.0 (2.8)
Sex		
Male	11 852 (88.5)	10 347 (77.3)
Female	1540 (11.5)	3045 (22.7)
Rank		
Enlisted	12 707 (94.9)	12 707 (94.9)
Officer	685 (5.1)	685 (5.1)
Occupation		
Noncombat	10 051 (75.1)	10 066 (75.2)
Combat	3341 (24.9)	3326 (24.8)
Race and ethnicity		
American Indian or Alaska Native, other, and unknown[a]	352 (2.6)	382 (2.9)
Asian or Pacific Islander	670 (5.0)	667 (5.0)
Black, non-Hispanic	2153 (16.1)	2165 (16.2)
Hispanic	2364 (17.7)	2360 (17.6)
White, non-Hispanic	7853 (58.6)	7818 (58.4)
Service branch		
Air Force	2125 (15.9)	2137 (16.0)
Army	6825 (51.0)	6842 (51.1)
Marine Corps	2526 (18.9)	2537 (18.9)
Navy	1916 (14.3)	1876 (14.0)

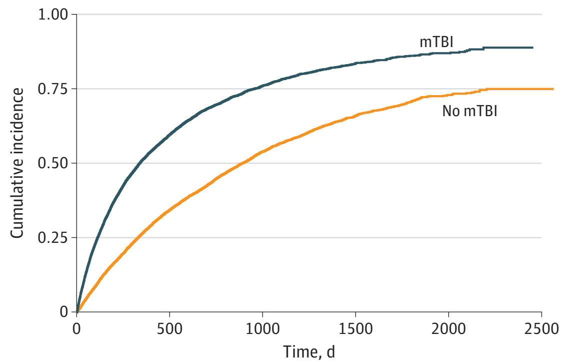
Abbreviation: mTBI, mild traumatic brain injury.

[a] Other or unknown race and ethnicity categories were grouped with American Indian or Alaska Native identifications due to limited sample size.

members, had an additional 102 MSKI events per 100 000 persons per day (Aalen estimate 1.02×10^{-3}; SE, 1.67×10^{-6}), after controlling for mTBI, age, rank, occupation, race and ethnicity, and service branch.

While the mTBI-by-sex interaction was not significant (*P* for interaction = .37), female service members had slightly greater hazards of mTBI-associated MSKI compared with male service members in the sex-stratified analysis (**Figure 4**). mTBI was associated with greater hazard of MSKI in models among female service members only (HR, 2.28; 95% CI, 1.92-2.70) and in models of male service members only (HR, 2.20; 95% CI, 2.11-2.29), after adjusting for age, race and ethnicity, occupation, rank, and service branch. On the absolute scale, compared with no mTBI, mTBI was associated with an additional 1030 MSKI events per 1000 person-years among female service

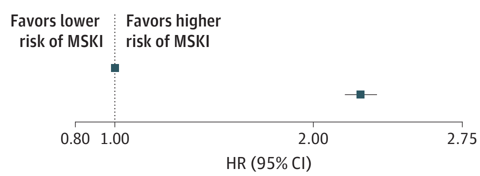
Figure 2. Unadjusted Cumulative Incidence Curve of Musculoskeletal Injury by Mild Traumatic Injury (mTBI) Group During the Full Follow-Up Period



	0	500	1000	1500	2000	2500
No mTBI						
No. at risk	13 392	6073	2347	776	194	2
No. of events	0	4048	1400	451	105	9
mTBI						
No. at risk	13 392	3280	993	308	70	0
No. of events	0	6997	1043	231	40	6

Figure 3. Dot Plot of Associations of Mild Traumatic Injury (mTBI) With Subsequent Musculoskeletal Injury (MSKI)

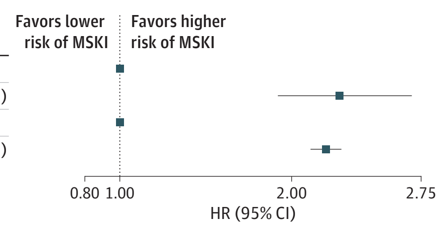
mTBI	No. of MSKI events	No. of MSKI events/1000 person-y	Aalen estimate (95% CI); robust SE	HR (95% CI)
No	6013	2863	[Reference]	1 [Reference]
Yes	8317	6363	2.58×10^{-3} (2.58×10^{-3} to 2.59×10^{-3}); 1.17×10^{-6}	2.24 (2.16-2.32)



Cox proportional hazards and Aalen additive models account for clustering between matched pairs and adjust for age, sex, rank, occupation, race and ethnicity, and service branch. HR indicates hazard ratio.

Figure 4. Dot Plot of Sex-Stratified Associations of Mild Traumatic Injury (mTBI) With Subsequent Musculoskeletal Injury (MSKI)

Sex	mTBI	No. of patients	No. of MSKI events	No. of MSKI events/1000 person-y	Aalen estimate (95% CI); robust SE	HR (95% CI)
Female	No	1540	812	3308	[Reference]	1 [Reference]
Female	Yes	3045	3045	7421	2.82×10^{-3} (2.80×10^{-3} to 2.85×10^{-3}); 1.36×10^{-5}	2.28 (1.92-2.70)
Male	No	11 852	5201	2799	[Reference]	1 [Reference]
Male	Yes	10 347	6231	6044	2.53×10^{-3} (2.53×10^{-3} to 2.53×10^{-3}); 1.60×10^{-6}	2.20 (2.11-2.29)



Cox proportional hazards and Aalen additive models account for clustering between matched pairs and adjust for age, rank, occupation, race and ethnicity, and service branch. HR indicates hazard ratio.

members only (Aalen estimate 2.82×10^{-3}; SE, 1.36×10^{-5}) and an additional 924 MSKIs per 1000 person-years among male service members only (Aalen estimate 2.53×10^{-3}; SE, 1.60×10^{-6}).

Discussion

Over a mean 1.28 years of follow-up, mTBI was associated with a greater hazard of subsequent MSKI in this matched retrospective cohort study of 26 784 US service members. Similar to previously published work, female service members had greater rates of MSKI compared with male service members. While the sex-by-mTBI interaction was not statistically significant, the association of mTBI with subsequent MSKI was slightly higher among female service members.

We found that mTBI was associated with a greater risk of subsequent MSKI, which aligns with past research in military and athlete populations. For example, in a recently published research abstract, of 129 750 US Army soldiers between 2016 and 2019, soldiers with TBI had 2.33 (95% CI, 2.29-2.37) times higher risk of MSKI compared with non-TBI controls.[29] When examining specific types of MSKI, a separate study of 468 collegiate athletes found that concussed athletes had 1.67 (95% CI, 1.11-2.53) higher risk of lower extremity MSKI.[15] In a meta-analysis including 661 athletes with concussion and 1757 without concussion, concussed athletes had 2.11 (95% CI, 1.46-3.06; I^2 = 59%) higher odds of subsequent MSKI compared with nonconcussed controls.[8] Overall, the direction and magnitudes of the effect sizes are similar to the HR of 2.24 that we observed. We extend these findings by including service members in the Air Force, Army, Marine Corps, and Navy, and by testing potential differences by sex in this population.

In testing whether associations vary by sex, we found that female service members had higher rates of MSKI compared with male service members over the study period, although the sex-by-mTBI interaction was not significant. Despite these nonsignificant interactions, females had higher crude rates of MSKI injury, regardless of mTBI status. These findings are consistent with prior literature that highlights these same patterns.[8] Importantly, we tested associations between mTBI and subsequent MSKI within each group to estimate sex-specific hazards. Here, we found that female service members had slightly higher risk of mTBI-associated MSKI compared with male service members, although the sex-by-mTBI interaction was not significant. These findings could be explained by differences in health care–seeking and risk-taking behaviors that may impact later-MSKI risk.[30,31]

Our findings correspond with literature that highlights the potential of mTBI increasing the risk of subsequent injury. mTBI often results in sensorimotor impairments that include disruption of the central vestibular and visual systems that control balance and motor processing and control.[32] The sensorimotor system helps regulate movement through processing of visual, vestibular, and somatosensory information to aid in postural stability.[33] Impaired balance processes may, in turn, place an mTBI-compromised individual at greater risk for MSKI. Residual deficits in motor control may remain even for years after mTBI, thus continuing the increased risk of MSKI.[34] In our sensitivity analysis, the risk of subsequent MSKI did not substantially differ when comparing the first year after mTBI and all available follow-up. Furthermore, in a recent cross-sectional study,[32] individuals with concussion history took longer to stabilize during a single-legged hop task compared with controls (mean difference, 0.35 seconds; 95% CI, 0.04-0.64 seconds). Decreased ability to complete this simple task alone suggests that balance control deficits may increase MSKI risk.[32] Furthermore, decreased ability to perceive and react to external threats and function in highly variable environments, especially during military training and operations, likely contributed to the findings observed in the current study.[35,36] Larger-scale studies with individual-level behavioral and physical performance data are needed to better assess the mTBI-to-MSKI pathway.

Another possible contributor to the increased risk of MSKI diagnoses may be related to behavioral disinhibition and alterations in central pain modulation that occur following mTBI. Individuals with mTBI frequently have decreased emotional and behavioral regulation following injury.[36,37] This disinhibition may have resulted in increased risk-taking behaviors, which potentially elevate risk of subsequent MSKI. Finally, service members with mTBI frequently experience chronic pain that affects long-term health-related quality of life.[36,38] Due to the diagnostic coding employed in our study, which encompassed both traumatic and repetitive microtraumatic MSKI, it is plausible that care-seeking for mTBI-related central-mediated pain may have contributed to the observed findings.

Clinically, it is recommended that service members with mTBI, as well as the leadership of the units in which they serve, be educated regarding the increased risk of MSKI following brain injury. To help reduce subsequent MSKI incidence, mitigating strategies could consider modification of activity and exposure. Comprehensive assessment and treatment of balance, motor performance, sensory integration, cognitive performance, and risk decision-making is also recommended. The employment of interdisciplinary teams of TBI specialists for the treatment of identified deficits, targeted secondary prevention interventions, and incremental return-to-duty activities in increasingly complex environments may help mitigate risk of subsequent MSKI following mTBI. These suppositions warrant further investigation in future research.

Strengths and Limitations

This study has several limitations. First, there may be information bias, given that all data were derived from the MDR from 2016 and onward. Our injury estimates may be underreported if service members sought care outside the Military Health System or had diagnoses with older *International Classification of Diseases* codes. Second, there may be selection bias due to loss to follow-up and healthy worker and/or volunteer bias in that service members needed to have been qualified and able to join the US military. Third, we were unable to account for repetitive injuries and mechanisms of injury, given the difficulty in delineating between an injury event and a subsequent injury event with the same *ICD* codes. Fourth, generalizability of our findings is limited to service member populations.

Our study had several notable strengths. We were able to leverage a unique dataset of all service members who had joined the military between 2016 and 2020. From these data, we generated a novel, early-career cohort with extended follow-up. In our analyses, we were able to estimate mTBI-associated risk of MSKI on both the absolute and relative scales.

Conclusions

In this cohort study of 26 784 service members, mTBI was associated with a greater hazard of subsequent MSKI. Female service members had greater rates of MSKI compared with male service members. While the sex-by-mTBI interaction was not significant, the association between mTBI and subsequent MSKI was greater among female service members. Given the negative impact of mTBI and MSKI on operational readiness, as well as the growing role of female service members in the US military,[18] further study of the biologic and behavioral mechanisms driving these differences will be crucial. This information can inform patient counseling on injury risk following mTBI.

ARTICLE INFORMATION

Accepted for Publication: April 26, 2026.

Published: June 18, 2026. doi:10.1001/jamanetworkopen.2026.19409

Corresponding Author: Alexander Ivan B. Posis, PhD, MPH, Warfighter Performance Department, Naval Health Research Center, 140 Sylvester Rd, San Diego, CA 92106 (alexanderivan.b.posis.ctr@health.mil).

Author Affiliations: Warfighter Performance Department, Naval Health Research Center, San Diego, California (Posis, Silder, Fraser, Sessoms); Military and Veterans Health Solutions, Leidos, Inc, San Diego, California (Posis); Epidemiology and Data Management Support Department, Naval Health Research Center, San Diego, California

(Zouris, MacGregor); Uniformed Services University of the Health Sciences, School of Medicine, Department of Physical Medicine and Rehabilitation, Bethesda, Maryland (Silder, Fraser); Operational Infectious Diseases Department, Naval Health Research Center, San Diego, California (Crouch).

Author Contributions: Dr Posis had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Posis, Silder, MacGregor, Crouch, Sessoms.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Posis, MacGregor, Fraser.

Critical review of the manuscript for important intellectual content: All authors.

Statistical analysis: Posis, Zouris, MacGregor.

Obtained funding: Sessoms.

Administrative, technical, or material support: Silder, MacGregor, Fraser, Crouch.

Supervision: Silder, MacGregor, Fraser, Crouch, Sessoms.

Conflict of Interest Disclosures: Dr Posis reported receiving grants from Congressionally Directed Medical Research Programs (CDMRP) during the conduct of the study as well as grants from the Alzheimer's Association outside the submitted work. Dr MacGregor reported receiving grants from CDMRP during the conduct of the study, as well as grants from the Bureau of Medicine and Surgery outside of the submitted work. Dr Fraser reported receiving grants from CDMRP in addition to grants from the Office of Naval Research. Dr Fraser also reported a patent for an Adaptive and Variable Stiffness Ankle Brace, US Provisional Patent Application No. 63254,474 pending; and provides consulting for Luna Laboratories. Dr Sessoms reported receiving grants from CDMRP during the conduct of the study. No other disclosures were reported.

Funding/Support: This work was supported by the Assistant Secretary of Defense for Health Affairs, through the CDMRP Traumatic Brain Injury and Psychological Health Research Program (TBIPHRP) (award no. CDMRPL-22-0-TP210321) under work unit no. 62333.

Role of the Funder/Sponsor: The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Data Sharing Statement: See Supplement 3.

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SUPPLEMENT 1.

eTable 1. International Classification of Disease 10th revision (ICD-10) codes for mild traumatic brain injury (TBI)
eTable 2. Characteristics of matched cohort by musculoskeletal injury (MSKI) outcome
eTable 3. Associations of mTBI with subsequent MSKI during the first year
eTable 4. Associations of mild traumatic brain injury (mTBI) with subsequent musculoskeletal injury, relative to no mTBI (reference), after considering additional washout periods
eTable 5. Associations of mild traumatic brain injury (mTBI) with subsequent musculoskeletal injury after additionally matching by sex (n = 19 538)
eFigure 1. Love Plot of Mean Differences in Covariate Values Between Mild Traumatic Brain Injury Cases and Controls
eFigure 2. Plot of Schoenfeld Residuals for Cox Proportional Hazards Models
eFigure 3. First Year Unadjusted Cumulative Incidence and Survival Table of MSKI by mTBI Group

SUPPLEMENT 2.

eTable 6. International Classification of Disease 10th revision (ICD-10) codes for musculoskeletal injury defined by The Neuromusculoskeletal Epidemiological Outcome (NEO)

SUPPLEMENT 3.

Data Sharing Statement