Journal of Athletic Training 2025;60(3):245–251
doi: 10.4085/1062-6050-0414.24

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Association Between Pregnancy and Musculoskeletal Conditions in Active-Duty Military Service Members

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Context: Noncombat musculoskeletal conditions (MSKs) are endemic among service members and disproportionately affect females. Pregnancy and childbirth contribute to lower physical fitness assessment scores and higher body mass index, both risk factors for MSKs, for up to 1 year postpregnancy. However, there is a paucity of information regarding the impact of pregnancy on MSKs.

Objective: To explore the association between the postpregnancy period and incident MSKs.

Design: Retrospective, longitudinal cohort study.

Setting: Medical and administrative data from the Medical Assessment and Readiness System.

Patients or Other Participants: Female military service members with and without a pregnancy.

Main Outcome Measure(s): Months since pregnancy end, health history, and demographic and military service data were abstracted for each individual. Subsequent MSKs were identified with relevant International Classification of Diseases-10 codes. A multivariable logistic regression model assessed the association between the time since pregnancy end and MSK incidence.

Results: A total of 298 607 female service members were identified, of which 19 980 had a pregnancy. A larger percentage of postpregnancy service members (65.8%) had an MSK diagnosis than the nonpregnant cohort (60.3%). Adjusting for covariates, the model suggests a temporal influence on postpregnancy MSK incidence, such that service members 3 to 4 months and 5 to 6 months postpregnancy were more likely to be diagnosed with an MSK than the nonpregnant cohort. However, service members <2 months postpregnancy were less likely to be diagnosed with an MSK, and the odds of an MSK beyond 6 months decreased out to 24 months postpregnancy.

Conclusions: Pregnancy may increase a service member's odds of sustaining an MSK 3 to 6 months postpregnancy. Understanding the relationships between pregnancy and MSK risks may lead to changes in postpartum return-to-duty/activity policies, better enabling service members to care for themselves and their families.

Key Words: maternity leave, musculoskeletal injury, postpartum, rehabilitation

Key Points

- Female service members 3 to 6 months postpregnancy are more likely to receive a musculoskeletal diagnosis than nonpregnant female service members.
- Service members who are postpregnancy may benefit from training programs designed to mitigate musculoskeletal conditions.

Noncombat musculoskeletal conditions (MSKs) are endemic among military service members and disproportionately affect females.[1–3] MSKs constitute a leading cause of health care utilization and disability, account for roughly 60% of limited duty days, and diminish service member quality of life.[1] Most female service members are of childbearing age; however, little is known about the association between the postpregnancy period and MSK risk.[4] To facilitate a safe and timely return to occupational demands, more research is required to advance our knowledge and understanding of MSK risk postpregnancy in females with arduous occupations.

Female sex, low physical fitness, and higher body mass index (BMI) are among the 57 potential risk factors identified for MSKs in military service members.[3] Pregnancy and childbirth contribute to lower physical fitness assessment scores and higher BMI, known MSK risk factors, for up to 1 year postpartum.[5–9] Physiological changes during pregnancy, including increased ligament laxity and decreased bone mineral density, may also increase MSK risk.[10–14] The postpartum period is also associated with infant care activities that may contribute to overuse MSKs and sleep disruptions, an MSK risk factor.[15–18] However, there is a paucity of information regarding the impact of the postpregnancy period on MSKs.

Few studies have examined the influence of pregnancy and childbirth on MSKs in military settings.[19,20] One study reported female service members who gave birth had lower MSK rates

than female service members who did not give birth.[19] Possible explanations were those who gave birth potentially received care for minor MSKs during routine postpartum appointments and the conditions were not documented or the service members did not engage in the same level of physical activity as they did before pregnancy, effectively reducing their MSK risk. Since that study was published, combat roles have opened to female service members, potentially increasing physical demands and MSK risks.[21] One study among UK service members identified a greater number of work-days lost due to illness and injury 1 year postpregnancy compared to 1 year prepregnancy.[20] However, the UK study demonstrated methodological concerns and limitations, including the lack of a control group and limited sample size, and the postpregnancy regulations applicable during the study period are no longer extant. Thus, it is essential to examine the effects of the postpregnancy period on service member MSK risks and potential risk factors in greater detail.

With an estimated 64.9 live births per 1000 person-years in the active component of the US Armed Forces and up to 40% of female active-duty service members reporting at least 1 pregnancy during military service, understanding the association between the postpregnancy period and MSK risk may help inform training programs for optimal health and medical readiness.[4,22] Therefore, the purpose of this study was to explore the association between the postpregnancy period and incident MSKs in active-duty military service members while controlling for other MSK risk factors. We hypothesized the likelihood of an MSK would be higher in service members postpregnancy than in nonpregnant service members.

METHODS

Data Sources and Study Population

We conducted a retrospective cohort study using the Medical Assessment and Readiness System (MARS) database. The MARS database is a longitudinal dataset organized at the person-month level on the total US active-duty military service member population. It comprises select details of all digitally recorded health encounters and administrative data from the Military Health System Data Repository and the Defense Manpower Data Center. For this study, data were available on service members who served between October 2015 and March 2022. We restricted the study population to active-duty females who served in any Department of Defense branch during this time span ($N = 298\,607$), resulting in a longitudinal data set of 265 379.5 person-years (3 184 554 person-months) of active service. This study received an exempt determination from the local Human Research Protections Office.

Approach

The MARS database was queried to identify all pregnancies with at least 20 completed weeks gestation occurring among active-duty service members from January 2018 to March 2020. A washout period was observed from October 2015 to December 2017 to avoid the inclusion of prior pregnancies. Miscarriages before 20 weeks gestation and ectopic and molar gestation pregnancies were excluded. All other active-duty service females without a documented pregnancy of $\geq$20 weeks gestation were observed as nonpregnant controls. Individuals were retrospectively observed for MSKs 24 months before their first person-specific observation to control for prior MSKs and 24 months after the first person-specific observation. Due to peripartum complaints potentially confounding true new MSK detection in individuals with a pregnancy, follow-up began in the first month following the end of the pregnancy month. During the follow-up period, individuals were tracked for an observation endpoint that included an MSK incident, departure from service, occurrence of another pregnancy, or 24 months after the first person-specific observation, whichever occurred first. The Figure depicts a breakdown of service members by pregnancy status and MSK.

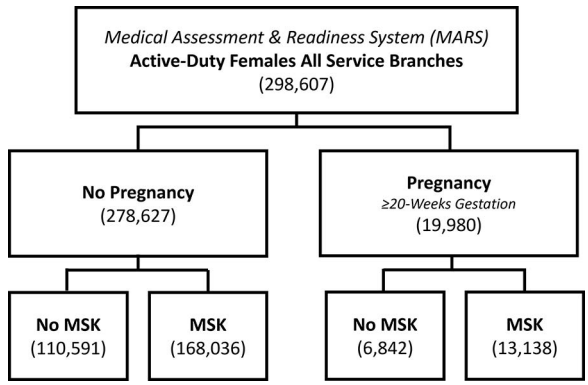

Figure. Subject flow diagram. Abbreviation: MSK, musculoskeletal condition.

Data Organization

Outcome Variable. MSKs were ascertained using International Classification of Diseases-10 (ICD-10) codes extracted from MARS using the service members' outpatient and inpatient medical encounters and civilian purchased care. The MSK ICD-10 code set used was based on a previously defined list (see Supplemental Table).

Predictor Variable. To better understand the association between the postpregnancy period and MSK incidence in service members, time since pregnancy end served as the primary predictor of an MSK. Based on the follow-up time available for each pregnant service member, individuals were classified as <2 months, 3 to 4 months, 5 to 6 months, 7 to 9 months, 10 to 12 months, 13 to 18 months, and 19 to 24 months since pregnancy end. Nonpregnant service members during the study period served as the reference group.

Covariates

Demographics. Demographic variables of interest included age, BMI, ethnicity, marital status, and race. Age, ethnicity, marital status, and race were defined based on each service member's monthly personnel record. Age had 4 categories ($\leq$21 years, 22 to 25 years, 26 to 31 years, and $\geq$32 years), ethnicity had 2 categories (Hispanic and non-Hispanic), marital status had 3 categories (never married, married, and formerly married), and race had 5 categories (Asian/Pacific Islander, White, Black, other, and unknown). BMI was defined based on readings taken during last-known outpatient encounters preceding pregnancy and resumed following pregnancy and had 5 categories (normal, underweight, overweight, obese, and no data).[23]

Health History. Health history data included prior MSKs, depression, and postpartum depression conditions and tobacco use. Individuals were retrospectively observed for MSKs,

depression (ICD-10 diagnosis codes beginning with F32 and F33 and code F34.1), and postpartum depression (ICD-10 diagnosis codes beginning with O90.6) 24 months before their first person-specific observation. As we used longitudinal data, at any given observation point, the variable for prior MSK, depression, or postpartum depression represents having had a diagnosis by that time. Thus, the variable effectively captured current and prior diagnoses. Self-reported tobacco use was dichotomized (yes or no) to reflect whether service members reported using tobacco during clinical care at any prior point in the longitudinal data.

Military Service. Potential military service confounders included length of service, service branch, and pay grade. Length of service, defined as years since entry into active-duty service, had 4 categories (≤1.5 years, >1.5 to 3.5 years, >3.5 to 8.0 years, and >8.0 years), service branch had 4 categories (Navy, Army, Air Force, and Marines), and pay grade had 3 categories (Junior Enlisted [≤E-4], Senior Enlisted [≥E-5], and Officers).

Statistical Analysis

Statistical analyses were conducted using Stata V.16.1 software (StataCorp). We calculated the proportion of controls and pregnant service members with and without an MSK incident and conducted χ^2 analyses at the last person-specific observation to assess unadjusted associations between each variable and MSK status. Individuals were observed until an observation endpoint (ie, an MSK incident, departure from service, occurrence of another pregnancy, or the conclusion of the follow-up period). Discrete-time logistic regression models assessed the association between the time since pregnancy end and MSK incidence while controlling for the previously described demographic, health history, and service covariates. Adjusted odds ratios and 95% confidence intervals were calculated for all variables included in the logistic regression model. The adjusted odds ratios in the discrete-time models represent similar effect estimates as hazard ratios produced by Cox regression models.[24] The α level was set a priori at $P < .05$.

RESULTS

Of the 298 607 females serving during the study period, 19 980 (6.69%) had a pregnancy with a gestation period of ≥20 weeks. A larger percentage of postpregnancy individuals ($n = 13\,138$; 65.8%) had a documented MSK than control individuals ($n = 168\,036$; 60.3%; $P < .001$; Table 1). Several demographic, health history, and military-related factors were also associated with MSK incidence, regardless of pregnancy status (Table 2). BMI was unknown during 0.97% of the person-months during which individuals were pregnant.

Our multivariable logistic regression model, adjusting for all covariates, identified a temporal influence on postpregnancy MSK incidence (Table 3), such that, compared with the control cohort, individuals 3 to 4 months and 5 to 6 months postpregnancy were more likely to be diagnosed with an MSK. However, individuals less than 2 months postpregnancy were 33% less likely to be diagnosed with an MSK. The odds of an MSK beyond 6 months postpregnancy also gradually decreased out to 24 months postpregnancy, where postpregnancy individuals were 5% to 48% less likely to experience an MSK than control individuals.

Table 1. Distribution of Subjects Without and With a Musculoskeletal Diagnosis (MSK) by Months Since Pregnancy End[a]

	Diagnosed with an MSK?	
	No	Yes
Control	110 591 (39.7%)	168 036 (60.3%)
Postpregnancy, months (overall)	6842 (34.2%)	13 138 (65.8%)
≤2	340 (13.6%)	2164 (86.4%)
3–4	349 (10.5%)	2982 (89.5%)
5–6	428 (16.2%)	2209 (83.8%)
7–9	641 (22.8%)	2167 (77.2%)
10–12	653 (32.4%)	1365 (67.6%)
13–18	1001 (39.8%)	1512 (60.2%)
19–24	3430 (82.3%)	739 (17.7%)

[a] All χ^2 comparisons in individuals without and with a musculoskeletal diagnosis were statistically significant ($P < .001$). Months since pregnancy end indicates the number of individuals whose follow-up ended during that time period.

The adjusted odds of an MSK were higher in individuals with a prior MSK, depression, or postpartum depression diagnosis than in individuals with no prior MSK, depression, or postpartum depression diagnosis. Compared with the youngest cohort (≤21 years), individuals who were 26 to 31 years old and ≥32 years old had higher odds of an MSK, but no differences were observed between the youngest cohort and individuals between 22 and 25 years of age. Individuals who were overweight and obese were at higher odds for an MSK, whereas individuals with no BMI data were at lower odds for an MSK, than those with a normal BMI. No differences were observed between individuals who were underweight and those with a normal BMI. Individuals who identified as non-Hispanic were at 5% higher odds of developing an MSK than Hispanic individuals. Married and formerly married individuals were at higher odds of an MSK than single individuals. For race, individuals who identified as White, Black, or other or their race was unknown (ie, not reported) were at higher odds for an MSK than Asian/Pacific Islanders. Individuals with a self-reported history of tobacco use had 10% higher odds of an MSK than individuals with no self-reported tobacco use history. Compared with Officers, Junior and Senior enlisted individuals were at significantly higher odds of an MSK. Individuals in the Army, Air Force, and Marines were at higher odds of an MSK than individuals in the Navy. Individuals with fewer years of service (≤1.50 years and 1.51 to 3.50 years) and those with more years of service (≥8.01 years) were at higher odds of an MSK than those in the midrange (3.51 to 8.00 years).

DISCUSSION

Pregnancy may increase a service member's odds for an MSK up to 14% in the 3- to 6-month postpregnancy timeframe compared with nonpregnant service members. Interestingly, beyond 6 months postpregnancy, the incidence of MSK continually declined compared with nonpregnant controls. These findings suggest the elevated odds of an MSK are transitory postpregnancy. Given female service members account for 16% of the active-duty military and most are of childbearing age, it is essential to understand these trends so that MSK mitigation strategies can be implemented.[4]

Prior studies indicate the risk of an MSK might be elevated in elite athletes following pregnancy; however, this is the first study to examine how the postpregnancy timeline contributes

Table 2. Total Study Population Numbers and χ^2 Results Comparing Covariate Distributions for Those Diagnosed and Not Diagnosed With a Musculoskeletal Condition

	Diagnosed with an MSK?	
	No	Yes
Health history		
Prior MSK diagnosis	$P < .001$	
No	94 901 (49.9%)	95 321 (50.1%)
Yes	22 532 (20.8%)	85 853 (79.2%)
Prior depression diagnosis	$P < .001$	
No	110 670 (40.0%)	166 129 (60.0%)
Yes	6763 (31.0%)	15 045 (69.0%)
Prior postpartum depression diagnosis	$P < .001$	
No	117 310 (39.3%)	180 887 (60.7%)
Yes	123 (30.0%)	287 (70.0%)
Tobacco use history	$P < .001$	
No	98 896 (40.3%)	146 680 (59.7%)
Yes	18 537 (35.0%)	34 494 (65.0%)
Demographics		
Age, y	$P < .001$	
≤21	39 976 (43.2%)	52 582 (56.8%)
22–25	36 108 (45.0%)	44 186 (55.0%)
26–31	25 951 (40.1%)	38 725 (59.9%)
≥32	15 398 (25.2%)	45 681 (74.8%)
Body mass index		
Normal	52 823 (39.4%)	81 155 (60.6%)
Underweight	1271 (46.1%)	1489 (53.9%)
Overweight	37 746 (36.0%)	67 042 (64.0%)
Obese	10 050 (33.3%)	20 143 (66.7%)
No data	15 543 (57.8%)	11 345 (42.2%)
Ethnicity	$P < .001$	
Hispanic	24 281 (40.8%)	35 174 (59.2%)
Non-Hispanic	93 152 (39.0%)	146 000 (61.0%)
Marital status	$P < .001$	
Never married	74 579 (43.0%)	98 743 (57.0%)
Married	36 441 (35.6%)	65 864 (64.4%)
Formerly married	6413 (27.9%)	16 567 (72.1%)
Race	$P < .001$	
Asian/Pacific Islander	8539 (42.4%)	11 578 (57.6%)
White	70 449 (40.5%)	103 557 (59.5%)
Black	27 051 (34.9%)	50 536 (65.1%)
Other	6885 (46.7%)	7872 (53.3%)
Unknown	4509 (37.1%)	7631 (62.9%)
Military service		
Paygrade	$P < .001$	
Officers	18 935 (40.3%)	28 076 (59.7%)
Junior enlisted (<E-4)	75 961 (42.2%)	103 943 (57.8%)
Senior enlisted (≥E-5)	22 537 (31.4%)	49 155 (68.6%)
Service branch	$P < .001$	
Navy	51 043 (57.3%)	38 062 (42.7%)
Army	24 631 (24.3%)	76 537 (75.7%)
Air Force	32 417 (38.9%)	50 863 (61.1%)
Marines	9342 (37.3%)	15 712 (62.7%)
Years since service entry	$P < .001$	
3.51–8.00	30 154 (45.3%)	36 368 (54.7%)
≤1.50	30 770 (34.3%)	58 864 (65.7%)
1.51–3.50	38 350 (51.3%)	36 443 (48.7%)
≥8.01	18 159 (26.8%)	49 499 (73.2%)

Abbreviation: MSK, musculoskeletal condition.

Table 3. Adjusted Odds Ratios for the Multivariable Logistic Regression Model

Predictor	*n*	Adjusted Odds Ratios (95% Confidence Interval)	*P* Value
Months postpregnancy			
Control	278 627	REF	
<2	2504	0.67 (0.64–0.70)	<.001
3–4	3331	1.14 (1.10–1.19)	<.001
5–6	2637	1.09 (1.04–1.14)	<.001
7–9	2808	0.95 (0.91–0.99)	.026
10–12	2018	0.82 (0.78–0.87)	<.001
13–18	2513	0.67 (0.64–0.71)	<.001
19–24	4169	0.52 (0.48–0.56)	<.001
Health history			
Prior MSK diagnosis			
No	190 222	REF	
Yes	108 385	2.13 (2.12–2.16)	<.001
Prior depression			
No	276 799	REF	
Yes	21 808	1.42 (1.39–1.45)	<.001
Prior postpartum depression			
No	298 197	REF	
Yes	410	1.28 (1.13–1.45)	<.001
Tobacco use history			
No	245 576	REF	
Yes	53 031	1.10 (1.09–1.12)	<.001
Demographics			
Age, y			
≤21	92 558	REF	
22–25	80 294	1.01 (0.99–1.02)	.244
26–31	64 676	1.09 (1.06–1.11)	<.001
≥32	61 079	1.44 (1.41–1.47)	<.001
Body mass index			
Normal	133 978	REF	
Underweight	2760	0.95 (0.89–1.00)	.052
Overweight	104 788	1.16 (1.14–1.17)	<.001
Obese	30 193	1.62 (1.59–1.65)	<.001
No data	26 888	0.43 (0.42–0.44)	<.001
Ethnicity			
Hispanic	59 455	REF	
Non-Hispanic	239 152	1.05 (1.03–1.06)	<.001
Marital status			
Never married	173 322	REF	
Married	102 305	1.06 (1.05–1.08)	<.001
Formerly married	22 980	1.12 (1.09–1.14)	<.001
Race			
Asian/Pacific Islander	20 117	REF	
White	174 006	1.15 (1.12–1.17)	<.001
Black	77 587	1.18 (1.15–1.20)	<.001
Other	14 757	1.16 (1.13–1.20)	<.001
Unknown	12 140	1.11 (1.08–1.15)	<.001
Military service			
Paygrade			
Officers	47 011	REF	
Junior enlisted (<E-4)	179 904	1.39 (1.36–1.41)	<.001
Senior enlisted (≥E-5)	71 692	1.15 (1.13–1.17)	<.001
Service branch			
Navy	89 105	REF	
Army	101 168	3.01 (2.97–3.05)	<.001
Air Force	83 280	1.78 (1.75–1.80)	<.001
Marines	25 054	2.36 (2.32–2.41)	<.001
Years since service entry			
3.51–8.00	66 522	REF	
≤1.5	89 634	2.01 (1.97–2.06)	<.001
1.51–3.50	74 793	1.08 (1.06–1.10)	<.001
≥8.01	67 658	1.09 (1.07–1.11)	<.001

Abbreviations: MSK, musculoskeletal condition; REF, reference.

to MSKs in US military service members.[25] Within the first 2 months of the end of pregnancy, our subjects were 33% less likely to have an MSK than nonpregnant controls. This finding suggests postpregnancy service members may be less susceptible to MSKs as they are typically on maternity leave with reduced or altered military or physical training during this time. Alternately, service members may be deferring care due to the demands of caring for a newborn. The increased odds of an MSK observed 3 to 4 months (14% greater odds) and 5

to 6 months (9% greater odds) postpregnancy compared with nonpregnant individuals support our theory that females are more susceptible to MSKs during the initial return-to-duty period. During our study period (2018–2020), all US military service branches authorized 12 weeks of parental leave. Thus, the 3-month postpregnancy milestone is the approximate time in which most of these females returned to duty and appear to be more susceptible to an MSK. It is also possible that the hormonal influences of pregnancy and lactation as well as the biomechanical and ergonomic stresses of infant care (eg, bottle feeding, carrying a car seat, and lifting or lowering an infant into a crib) contributed to the heightened odds observed in these service members.[10,26] For example, relaxin, a hormone responsible for altering tendon and ligament stiffness for childbirth, can take 5 months or more postpregnancy to return to normal.[27]

Pregnancy also contributes to increases in BMI and lower physical fitness up to 1 year postpartum, these are both known MSK risk factors.[3,6,8] Individuals in the Army were required to meet physical fitness and body composition standards within 6 months of the end of the pregnancy, whereas Sailors and Marines had 9 months and Airmen had 12 months. The pressure to meet fitness and body composition standards postpartum may have encouraged underfueling (ie, restricting calories) and/or overtraining, which could have contributed to the increased odds of an MSK observed in the postpregnant cohort. These directives have since been extended to 365 days for all service branches. The exact mechanisms contributing to the greater MSK odds 3 to 6 months from the end of pregnancy are not fully understood; but implementing MSK risk mitigation strategies before this period is critical to ensure the successful return-to-duty for postpregnancy service members.

All demographic, health history, and military service variables in our multivariable model were significantly different between service members with and without a diagnosed MSK. Most of these factors are known to increase MSK risk.[3] Service members with prior MSK, depression, or postpartum depression diagnoses were at greater odds for an MSK. The prior MSK finding is not novel, but to our knowledge, this is one of the first studies to examine the association between prior MSK, depression, and postpartum depression diagnoses and postpregnancy MSK incidence. Similar to our findings, 1 prior study noted that feeling down, depressed, or hopeless was associated with a greater MSK risk in service members.[28] The greater MSK odds associated with age (>26 years), BMI (overweight or obese), ethnicity (non-Hispanic), marital status (married or formerly married), race (White, Black, other, or unknown), and tobacco use (yes) are also well supported in the literature, although for some (ethnicity, race), no distinct associations are present.[3] Similarly, the greater odds of an MSK observed by military service branch are also reinforced by the literature, with those serving in the Navy being at lower odds of an MSK.[3] This is likely attributable to the varying occupational demands and exposures across service branches. Similar trends were observed for pay grade and years of service, with those at lower pay grades and with fewer years of service (<1.5 years) and the most years of service (≥8.01 years) more likely to have an MSK than those at higher pay grades and with 3.51 to 8.00 years of service, respectively. Individuals with no BMI data were less likely to have an MSK than individuals with a normal BMI. The BMI data are likely missing because the service members have not seen a health care provider, which likely equates to these individuals being less likely to seek care for an MSK. Although many of these factors are nonmodifiable, it is important to understand how they influence MSKs and consider such factors when implementing interventions to mitigate MSK risks in the postpregnancy period.

Our findings suggest service members are more susceptible to MSKs in the 3- to 6-month timeframe postpregnancy. Thus, to promote a healthy military fighting force, additional postpregnancy leave time, beyond 12 weeks, may be warranted. To that end, the US Navy is advocating for convalescent leave in addition to parental leave to ensure that service members are medically ready when returning to duty.[29] Additionally, evidence-backed physical training interventions to maintain health and fitness during pregnancy and restore prepregnancy health and fitness are needed. To this end, each service branch has its own guidebook or program to assist service members in returning to prepregnancy fitness levels. However, implementation standards vary across service branches, and commands and compliance with these programs are largely unknown. For example, with the Army's Pregnancy Postpartum and Physical Training (P3T) program, service members generally report feeling supported to participate; however, in a 2014 study, program utilization rates were relatively low, with one-third of service females not completing any portion of the P3T.[30,31] The Postpartum Exercise and Return to Fitness: Optimize Readiness for Military Mums (PERFORM) study is currently underway to investigate the efficacy of postpartum rehabilitation and physical development on occupational performance, musculoskeletal health, pelvic health, psychological well-being, and quality of life.[32] The study intervention includes specific pelvis, hip, and abdominal exercises as well as resistance and high-intensity interval training.[32] Findings from the PERFORM study may have important clinical implications to mitigate MSK postpregnancy.

The current research pertaining to pregnancy, childbirth, and the postpartum period in service members is broad in scope, with little emphasis on MSKs.[20,33,34] Large prospective studies are needed to better understand the impact of pregnancy on MSK risk. Further work in much broader populations, including individuals in other arduous occupations (eg, firefighters and police), and the general public will also be required to confirm our findings. Future research should focus on determining optimal leave time and evidence-based strategies to mitigate MSK risks postpregnancy. With our data collected before implementation of many of the military postpartum leave and fitness program changes, the impact of these policies on MSK risk should be explored with high-quality randomized-controlled trials and robust cohort studies as appropriate. Understanding which policies mitigate MSKs postpregnancy is critical to service members' health and wellness and overall medical readiness.

Limitations

Major strengths of our study include the large cohort and robust postpregnancy follow-up period. We believe this is the largest retrospective study to date to examine MSK incidence postpregnancy in a distinct, physically fit cohort. Thus, these findings may have applications to athletes and physically active civilians postpregnancy. Additionally, the individuals included in this study had continuous access to health care via the Military Health System. Thus, unlike the general public, health care access barriers, such as high cost and geographic isolation, were limited. Despite the strengths, this study is not

without limitations. First, our MSK data were limited to diagnostic coding, which can be imprecise and require the service member to seek medical care. Second, we could not account for every possible demographic, health history, or military service factor; we were limited to what was accessible within the MARS database. Finally, other postpregnancy factors (eg, sleep disruptions and hormone levels) that influence MSK risk could not be accounted for.

CONCLUSIONS

Pregnancy may increase a service member's odds of sustaining an MSK in the 3- to 6-month postpregnancy timeframe. However, this greater odds of an MSK is transient, with lower odds of an MSK observed immediately postpregnancy (<2 months) and beyond 6 months. Service member health history (MSK, depression, postpartum depression, and tobacco use), age, BMI, ethnicity, marital status, race, pay grade, service branch, and years of military service were also associated with MSK risk postpregnancy. Understanding the relationships between pregnancy and MSK risks may lead to changes in postpartum return-to-duty/activity policies, enabling service members to better care for themselves and their families. Collectively, these benefits will improve service member medical readiness and quality of life.

DISCLAIMER

The views expressed in this manuscript are of those of the authors and do not necessarily reflect the views, opinions, or policies of the Uniformed Services University of the Health Sciences, the US Departments of Army/Navy/Air Force, Department of Defense, nor the US Government.

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SUPPLEMENTAL MATERIAL

Supplemental Table. International Classification of Disease-10 codes used to identify musculoskeletal diagnoses.

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