

4000 DEFENSE PENTAGON WASHINGTON, D.C. 20301-4000

The Honorable Adam Smith Chairman Committee on Armed Services U.S. House of Representatives JUL 2:3 2020

Dear Mr. Chairman:

Washington, DC 20515

The Department's response to section 748 of the National Defense Authorization Act for Fiscal Year 2020 (Public Law 116-92) is enclosed. The Secretary of Defense is required to submit a report on the findings of the Millennium Cohort Study relating to the gynecological and perinatal health of women members of the Armed Forces, within 180 days of enactment. On May 19, 2020, we sent an interim response indicating that the report would be delayed.

Thank you for your continued support for our Service members, our veterans, and their families. I am sending an identical letter to the Committee on Armed Services of the Senate.

Sincerely,

//SIGNED//
Matthew P. Donovan
USD for Personnel & Readiness



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The Honorable Jack Reed Ranking Member Committee on Armed Services United States Senate Washington, DC 20510

JUL 2 3 2020

Dear Senator Reed:

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The Honorable James M. Inhofe Chairman Committee on Armed Services United States Senate Washington, DC 20510 JUL 2 3 2020

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The Honorable William "Mac" Thornberry Ranking Member Committee on Armed Services U.S. House of Representatives Washington, DC 20515

JUL 2:3 2020

Dear Representative Thornberry:

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REPORT TO THE COMMITTEES ON ARMED SERVICES OF THE SENATE AND HOUSE OF REPRESENTATIVES



Section 748 of the National Defense Authorization Act for Fiscal Year 2020 (Public Law 116-92) Initial Report on Millennium Cohort Study Relating to Women of the Armed Forces

July 2020

The estimated cost of report or study for the Department of Defense (DoD) is approximately \$14,000 for the 2020 Fiscal Year. This includes \$14,000 in expenses and is DoD labor. Generated on April 7, 2020 RefID: B-F1E0CF2

TABLE OF CONTENTS

EXECUTIVE SUMMARY	2
INTRODUCTION	2
BACKGROUND	2
DATA COLLECTION	3
GENERAL FINDINGS OF THE MILLENNIUM COHORT STUDY PERTAINING TO GYNECOLOGICAL AND PERINATAL HEALTH	3
OTHER HEATLH CONCERNS RELATED TO THE GYNECOLOGICAL AND PERINATAL HEALTH OF WOMEN OF THE ARMED FORCES:	8
RESEARCH PROJECTS ASSOCIATED WITH GYNECOLOGICAL AND PERINATAI HEALTH OF WOMEN OF THE ARMED FORCES	
AREAS WHERE THE MILLENNIUM COHORT STUDY CAN INCREASE EFFORTS TO CAPTURE DATA AND PRODUCE STUDIES IN THE FIELD OF GYNECOLOGICAL AND PERINATAL HEALTH OF WOMEN OF THE ARMED FORCES	8
ACTIVITIES UNDERWAY TO INCREASE EFFORTS TO CAPTURE DATA AND PRODUCE STUDIES IN THE FIELD OF GYNECOLOGICAL AND PERINATAL HEALTH OF WOMEN OF THE ARMED FORCES	
CONCLUSION	
REFERENCES 1	
APPENDICES1	3
Appendix A: Glossary1	3
Appendix B: List of Acronyms	5

EXECUTIVE SUMMARY

This report is in response to the section 748 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2020 (Public Law 116-92) requirement for the Secretary of Defense to submit a report on "Millennium Cohort Study Relating to Women Members of the Armed Forces" to the Committees on Armed Services of the Senate and the House of Representatives, within 180 days of enactment and annual reports thereafter through January 31, 2022. This initial report describes findings of the Millennium Cohort Study relating to the gynecological and perinatal health of women members of the Armed Forces.

The Millennium Cohort Study, a longitudinal, voluntary assessment of a "cohort" or group of Service members conducted every 5 years, is the only Department of Defense (DoD)-wide study that is able to combine self-reported survey data with existing enterprise databases for more than 200,000 Service members, of which 31 percent are women. This capability enabled the Millennium Cohort Study to collaborate with the DoD Birth and Infant Health Research (BIHR) program, on analyses of two peer-reviewed publications relevant to the reproductive health of Service women. These analyses addressed whether deployment in support of recent conflicts in Iraq and Afghanistan was a risk factor for subsequent maternal depression, miscarriage, impaired fecundity, and infertility (Ippolito et al., 2017; Nguyen et al., 2013). Findings suggested that these deployments did not increase risks for miscarriage, impaired fecundity, or infertility among Service women. Additionally, results associated with maternal depression were consistent with previously reported studies for the general and active duty populations, indicating similar rates for maternal depression regardless of deployment experience.

INTRODUCTION

To date, the Millennium Cohort Study has published two peer-reviewed publications relevant to Service women's reproductive health. A 2013 article, published in the Journal of Women's Health, examined the relationship between maternal depression and deployment in support of the operations in Iraq and Afghanistan (Nguyen et al., 2013). A 2017 article published in Women's Health Issues examined risk factors associated with miscarriage, impaired fecundity, and infertility during the conflicts in Iraq and Afghanistan (Ippolito et al., 2017). The findings of these articles are summarized in the following sections.

BACKGROUND

The Millennium Cohort Study was established in response to the Strom Thurmond NDAA for FY 1999 (Public Law 105-161). The study is "a longitudinal study to evaluate data on the health conditions of members of the Armed Forces upon their return from deployment on military operations for purposes of ensuring the rapid identification of any trends in diseases, illnesses, or injuries among such members as a result of such operations" (United States, 1999). The design of the study is a prospective cohort study of a representative sample of service members from all branches (Army, Navy, Marine Corps, Air Force, Coast Guard) and components (i.e., Active, Reserve, National Guard) of the U.S. Armed Forces (Smith, 2009).

The Millennium Cohort Study is executed at the Naval Health Research Center (NHRC) in San Diego, CA, and is sponsored by the Defense Health Program. Numerous databases have been linked with Millennium Cohort Study participants' survey data, including DoD personnel and deployment records, DoD TRICARE medical encounter data, pharmacy transactions, DoD BIHR program data, Department of Veterans Affairs (VA) medical records, and mortality records. The Millennium Cohort Study's unique capability to link and study multiple DoD-wide data sources provides the potential to evaluate the relationship of health, behaviors, events, and exposures to deployments in cohort enrolled Service members.

DATA COLLECTION

This report includes previously published self-reported survey data from the Millennium Cohort Study. All surveys have been approved by the Office of Management and Budget (OMB) and the Information Management Control Officer (OMB Control #: 0703-0064/RCS: DD-NAVY(AR)2678). All data is stored, maintained, and analyzed on secure servers at NHRC. The research summarized in this report was conducted in compliance with all applicable Federal regulations governing the protection of human subjects in research and was approved by the institutional review board at NHRC (Protocol NHRC.2000.0007).

Participants in the Millennium Cohort Study complete a survey every 3-5 years either online or in paper format by postal mail. These surveys ascertain participants' psychological and physical health outcomes, health behaviors, quality of life, military deployment exposures, and other life experiences.

Multiple sources (DoD personnel and deployment records, DoD TRICARE medical encounter data, pharmacy transactions, DoD BIHR program data, VA medical records, and mortality records) are linked to Millennium Cohort Study participants' survey data. This capability enables comparative analysis between self-reported qualitative data and quantifiable diagnosis and outcomes data, enhancing data integrity by improving data accuracy and data verification.

The studies summarized in this report utilized data from three DoD databases in combination with the survey data. Millennium Cohort Study participants' electronic DoD personnel and military deployment data were obtained from the Defense Data Manpower Center (DMDC). Medical encounter data were obtained from the Military Health System Data Repository (MDR) for all eligible active duty study participants. Additionally, dates of birth and birth defects for active duty participants' children were obtained from the DoD BIHR program.

GENERAL FINDINGS OF THE MILLENNIUM COHORT STUDY PERTAINING TO GYNECOLOGICAL AND PERINATAL HEALTH

OVERVIEW: Millennium Cohort Study data was previously analyzed to examine reduced fertility, specifically impaired fecundity, infertility, and miscarriage; and maternal depression

among Service women. Findings from these analyses were published in two peer-reviewed articles (Ippolito et al., 2017; Nguyen et al., 2013).

REDUCED FERTILITY: Reduced fertility was addressed in this report by examining miscarriage, impaired fecundity, and infertility among Service women in the Millennium Cohort Study. Miscarriage is the spontaneous loss of a fetus before the 20th week of pregnancy and infertility is the failure to achieve a pregnancy after 12 months or more of regular unprotected sexual intercourse (MedlinePlus, 2020; Chandra, 2013). Impaired fecundity and infertility are closely related; whereas infertility is associated with the clinical diagnosis of an individual's failure to achieve a pregnancy after 12 months or more of regular unprotected sexual intercourse, impaired fecundity does not impose a time period of regular unprotected sexual intercourse and describes the physical ability of a woman to have a child, not just conceive a pregnancy (Chandra, 2013). For example, the population of women surveyed could be associated with impaired fecundity if they reported the inability to produce offspring via unprotected sexual intercourse within 6 months; however, these individuals would likely not receive a clinical diagnosis of infertility until after 12 months elapsed. The Millennium Cohort Study surveys captured miscarriage and impaired fecundity outcomes. Sub-analyses were conducted using International Classification of Diseases (ICD)-9 codes to verify infertility and miscarriage outcomes among Service women on active duty.

The study population for these analyses (miscarriage, n = 3,366; impaired fecundity, n = 11,183) consisted of Service women between the ages of 18 and 45 years from the first (2001-2003) and second (2004-2006) enrollment panels of the Millennium Cohort Study. Service women were asked if, within the last 3 years, they had a miscarriage, or had tried and been unable to become pregnant. To corroborate the findings from self-reported miscarriage and impaired fecundity, additional analyses captured miscarriage events and infertility diagnosis associated with active duty women medical encounter data obtained from the MDR, and methodology developed by the BIHR program (Conlin et al., 2013; Ryan et al., 2001).

This study examined three exposures of interest: deployment experience, cumulative deployment length, and life stressors. Deployment experience was further categorized as nondeployed, deployed without combat, and deployed with combat. Cumulative deployment length was calculated as the total number of days deployed within the 3-year period before their 2004-2006 survey date, and was categorized as 0, 1-180, and more than 180 days. Deployment dates were obtained from the Contingency Tracking System maintained by DMDC. Participants who returned from deployment before completing the 2004-2006 survey were defined as deployers. Among those who deployed, combat was determined based on at least one self-reported response of being personally exposed to any of the following: dead and/or decomposing bodies; maimed soldiers or civilians; prisoners of war/refugees; witnessing death; or witnessing physical abuse.

The life stressors exposure was also assessed on the follow-up survey. Participants were asked to identify if they experienced specific life stressors provided in the survey (e.g., divorce or separation, major financial problems, and sexual assault), and subsequently classified as having low/mild or moderate/major life stressors based on a modified version of the Social

Readjustment Rating Scale scoring system (Hobson et al., 1998).

Overall, deployment and combat experiences were not associated with miscarriage, self-perceived impaired fecundity, or infertility in this large cohort of service women. These findings were consistent with outcomes identified from subjective surveys and objective medical records. Although none of the main exposures were found to be statistically significant in association with miscarriage or impaired fecundity, it is notable that the odds ratio was greater than 1.0 for those deployed with combat experience in all models. Life stressors, which have historically been negatively associated with reproductive health outcomes, and military-specific characteristics (such as Service branch or component, occupation, and rank), did not appear to be associated with miscarriage or impaired fecundity after adjustment for other factors.

Miscarriages were not associated with deployment experience, deployment length, or life stressors. The study population for the miscarriage analyses consisted of 3,366 service women who reported having a pregnancy during the approximate 3-year follow-up period. Among these women, 31.0 percent reported a miscarriage on the follow-up survey. Deployment experiences, cumulative deployment length, and life stressors were not associated with miscarriage after adjusting for demographic, military, and health factors. Additional analyses restricted to 1,041 eligible active duty Service women, 13.1 percent had a miscarriage event ascertained from medical records. Consistent with findings for miscarriages reported on the survey, miscarriages identified from medical records were not associated with deployment experiences, cumulative deployment length, or life stressors. Other factors found to be associated with elevated risk of miscarriage were older age, not being married, having a prior medical condition (hypertension, thyroid condition, seizures, lupus, diabetes, rheumatoid arthritis, or frequent bladder infection), cigarette smoking, and a prior history of miscarriage.

Similar to miscarriage, impaired fecundity was not found to be associated with deployment experience. The analyses of impaired fecundity examined 11,183 Service women. Self-perceived impaired fecundity was endorsed by 11.3 percent of these women. Deployment experiences, cumulative deployment length, and life stressors were not associated with self-perceived impaired fecundity after adjusting for demographic, military, and health factors. However, separate analyses from previous studies suggest that age at first enrollment panel, race/ethnicity, heavy weekly alcohol drinking, cigarette smoking, psychiatric symptoms, and previously reported impaired fecundity were associated with risk for self-reported impaired fecundity.

Medical records for diagnosis codes of infertility were assessed for the 4,079 eligible active duty Service women. To our knowledge, this was the first time, on a large scale, perceived infertility was correlated with a clinical diagnosis of infertility. Compared to the self-perceived impaired fecundity of 11.3 percent, of the eligible active duty Service women, 5.2 percent presented with a clinical diagnosis of infertility. Consequently, no significant associations were observed between infertility and deployment experiences, cumulative deployment length, or life stressors, which was consistent with results from self-reported impaired fecundity.

Findings for the adverse reproductive health outcomes examined in these analyses were similar

to those in the general population. These results suggest there was no association between deployment and specific reproductive health outcomes.

DEPRESSION DURING AND AFTER PREGNANCY: Service women experience maternal depression at similar rates to women in the general population. Postpartum depression affects approximately 10-22 percent of new mothers (Gaynes et al., 2005; O'Hara & McCabe, 2013; Peindl et al., 2004); for comparison, the rate of postpartum depression previously reported in a sample of active duty Service women was approximately 20 percent (Appolonio & Fingerhut, 2008). The analysis summarized in this report examined the risk for depression among women who deployed either before or up to three years after birth, providing valuable information regarding the approximately 15,000 women on active duty in the U.S. military that give birth every year (Bukowinski et al., 2017). Results were consistent with previously reported studies for the general and active duty populations, indicating approximately 8-17 percent of Service women experience maternal depression regardless of deployment experience.

The study population for the main analyses consisted of active duty women from the first (2001-2003) and second (2004-2006) enrollment panels of the Millennium Cohort Study. A total of 1,660 women completed both the baseline and first follow-up surveys and gave birth to one or more singleton infants during the time period between the baseline and follow-up surveys. Depression after childbirth was assessed at the follow-up survey using the simple scoring method of the nine depression items from the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire (PHQ) (Gjerdingen et al., 2009).

The main exposure of interest was deployment in support of the operations in Iraq and Afghanistan. Deployment both before and after childbirth was examined separately and categorized into three levels of exposure: not deployed, deployed without combat exposure, and deployed with combat exposure. Deployment dates were obtained from the Contingency Tracking System of DMDC. Deployed Service women were classified as having combat exposure if they endorsed one or more of the following survey questions about being personally exposed in the 3 years before follow-up: person's death due to war, disaster, or tragic event; physical abuse; dead or decomposing bodies; maimed soldiers or civilians; or prisoners of war or refugees. Deployment before childbirth was assessed from the baseline survey until the date of childbirth, and deployment after childbirth was assessed from date of childbirth until the follow-up survey completion date.

Dates of birth for children born to study participants, as well as any birth defects detected before follow-up, were obtained from the DoD BIHR program (Khodr et al., 2018). Other potential risk factors considered in this study included demographic and military characteristics, as well as cigarette smoking status, potential alcohol dependence, posttraumatic stress disorder, depression at baseline, and previous mental health diagnosis or current use of psychotropic medication.

Of the Service women eligible for these analyses, 72 percent did not deploy, 12 percent deployed without combat, and 16 percent deployed with combat before childbirth. After childbirth, 86 percent of Service women did not deploy, 6 percent deployed without combat and 8 percent deployed with combat.

Women that deployed and reported combat related exposures prior to childbirth had the highest prevalence of maternal depression (16.6 percent), followed by those who did not deploy (10.1 percent), and women who deployed without combat (8.4 percent). Similarly, the highest prevalence of depression for women who deployed after childbirth was among those who deployed with combat (15.7 percent), followed by those who did not deploy (10.7 percent), and women who deployed without combat (6.5 percent). After adjusting for demographic characteristics and health factors, women who deployed with combat after childbirth were two times as likely to have maternal depression compared to women who did not deploy after childbirth (adjusted odds ratio: 2.01, 95 percent confidence interval: 1.17-3.43). However, no statistically significant association was observed between deployment occurring before childbirth and maternal depression.

Additional analyses were conducted to further examine post-deployment depression. The study population for these additional analyses consisted of active duty women in the first and second enrollment panels of the cohort who had deployed in support of the recent operations in Iraq and Afghanistan. The population consisted of women who both did and did not give birth between baseline and follow-up. Women were classified as deployed with no combat, no childbirth; deployed with no combat, childbirth; deployed with combat, childbirth.

Among the deployed Service women examined in these additional analyses, 20.1 percent experienced childbirth. Service women who experienced combat during deployment and gave birth were not more likely to have depression compared with women who deployed with combat and did not give birth. Additionally, women who did not experience combat during deployment and did not give birth were less likely to have depression compared with women who experienced combat and did not give birth.

Findings suggest women who deployed and reported combat exposures after childbirth were more likely to screen positive for depression than women who did not deploy after childbirth. However, these main findings were unable to conclude if the increased risk of depression among combat deployers after childbirth was attributable to experiencing combat, experiencing childbirth and leaving a young child, or a combination of these factors.

To better understand the relationships among deployment, childbirth, and depression, comparative analysis was performed utilizing data from a previous Millennium Cohort investigation, which found that women who deployed and experienced combat have an increased risk of depression compared to women who did not deploy (Wells et al., 2010). The comparison assessed prevalence rates and trends of depression regardless of childbirth status (new onset depression vs. maternal depression).

The highest estimated prevalence of new onset depression for women was among those who deployed with combat experience (15.7 percent), followed by those who did not deploy (7.7 percent), and women who deployed without combat (5.1 percent) (Wells et al., 2010). Thus, it can be inferred that an increased rate of depression may be primarily attributed to combat experience while deployed, and not associated with childbirth. In comparison, military women

in the general population experience postpartum depression at an estimated rate of 10 percent-22 percent; comparatively, the prevalence of major depressive episodes for women in the general population is estimated at 9 percent (Elfein, 2019; NIMH, 2019).

Based on these findings, the Millennium Cohort Study longitudinal assessments will continue to include questions to determine if women who deploy and report combat exposures after childbirth are more likely to screen positive for maternal depression.

OTHER HEATLH CONCERNS RELATED TO THE GYNECOLOGICAL AND PERINATAL HEALTH OF WOMEN OF THE ARMED FORCES:

This initial report reflects existing findings relating to gynecological and perinatal health of women. Subsequent annual Millennium Cohort Study reports will conduct other analyses pertaining to gynecological and perinatal health, including diseases, disorders, and conditions that affect the functioning of reproductive systems, maternal mortality and severe maternal morbidity, birth defects, developmental disorders, low birth weight, preterm birth, or menstrual disorders.

RESEARCH PROJECTS ASSOCIATED WITH GYNECOLOGICAL AND PERINATAL HEALTH OF WOMEN OF THE ARMED FORCES

There are no Millennium Cohort Study research projects relevant to reproductive systems, maternal mortality, severe maternal morbidity, birth defects, developmental disorders, low birth weight, preterm birth, reduced fertility, menstrual disorders, or other health concerns that have concluded during the year covered by this report.

AREAS WHERE THE MILLENNIUM COHORT STUDY CAN INCREASE EFFORTS TO CAPTURE DATA AND PRODUCE STUDIES IN THE FIELD OF GYNECOLOGICAL AND PERINATAL HEALTH OF WOMEN OF THE ARMED FORCES

In order to maintain a population of active duty women in their childbearing years, it will be necessary for the Millennium Cohort Study to enroll a new panel of current Service members. Currently, 70 percent of women enrolled in the study are no longer serving in the Armed Forces. The study will continue to assess selected gynecological and perinatal outcomes among women still in military service as well as those who are now veterans, but the ascertainment of the outcomes of interest from medical records is limited to the period of time in active duty service. A new enrollment panel that includes current Service women will enhance the capability of the Millennium Cohort Study to continue assessing gynecological and perinatal outcomes and

examine associations with their military service and deployment histories.

The Millennium Cohort Study can increase data collection efforts by further expanding the gynecological and perinatal questions included on the survey assessments. The most recent survey data collection that started in October 2019 expanded the questions in the women's health section to include items on pregnancy, birth, menstrual periods, contraception, and breastfeeding. These data will be available for analysis in 2022.

ACTIVITIES UNDERWAY TO INCREASE EFFORTS TO CAPTURE DATA AND PRODUCE STUDIES IN THE FIELD OF GYNECOLOGICAL AND PERINATAL HEALTH OF WOMEN OF THE ARMED FORCES

The Millennium Cohort Study can increase its effort to capture data and produce studies in the field of gynecological and perinatal health of Service women through its active collaboration with the DoD BIHR program.

CONCLUSION

The Millennium Cohort Study published two peer-reviewed publications related to the gynecological and perinatal health of women in the Armed Forces. These initial analyses observed that military deployment did not increase the risk of experiencing a miscarriage, infertility, or impaired fecundity. Additionally, results associated with maternal depression were consistent with previously reported studies for the general and active duty populations, indicating similar rates for maternal depression regardless of deployment experience.

REFERENCES

- Agarwal, A., Aponte-Mellado, A., Premkumar, B. J., Shaman, A., & Gupta, S. (2012). The effects of oxidative stress on female reproduction: a review. *Reprod Biol Endocrinol*, 10, 49. doi:10.1186/1477-7827-10-49
- Appolonio, K. K. and Fingerhut, R. (2008). Postpartum depression in a military sample. *Military Medicine*, 173, 11. DOI: 10.7205/milmed.173.11.1085
- Bukowinski, A. T., Conlin, A. M. S., Gumbs, G. R., Khodr, Z. G., Chang, R. N., & Faix, D. J. (2017). Department of Defense Birth and Infant Health Registry: select reproductive health outcomes, 2003-2014. *MSMR*, 24(11), 39-49.
- Chandra, A., Copen, C.E., Stephen, E.H. (2013). Infertility and Impaired Fecundity in the United States, 1982-2010: Data from the National Survey of Family Growth. *National Health Statistics Reports, no 67.* Hyattsville, MD: National Center for Health Statistics.
- Conlin, A. M., Bukowinski, A. T., Sevick, C. J., DeScisciolo, C., & Crum-Cianflone, N. F. (2013). Safety of the pandemic H1N1 influenza vaccine among pregnant U.S. military women and their newborns. *Obstet Gynecol*, *121*(3), 511-518. doi:10.1097/AOG.0b013e318280d64e
- Defense Health Board. (2015). *Deployment Pulmonary Health*. Falls Church, VA. Retrieved from https://www.health.mil/Reference-Center/Reports/2015/02/11/Deployment-Pulmonary-Health
- Defense Health Board. (2019). *Healthy Military Family Systems: Examining Child Abuse and Neglect*. Falls Church, VA. Retrieved from https://www.health.mil/Reference-Center/Presentations/2019/08/06/Healthy-Military-Family-Systems-Examining-Child-Abuse-and-Neglect
- Elfein, J. (2019). Major depressive episode in the past year among U.S. adults by age and gender 2018. Retrieved from https://www.statista.com/statistics/252312/major-depressive-episode-among-us-adults-by-age-and-gender/
- Gaynes, B. N., Gavin, N., Meltzer-Brody, S., Lohr, K. N., Swinson, T., Gartlehner, G., . . . Miller, W. C. (2005). Perinatal depression: prevalence, screening accuracy, and screening outcomes. *Evid Rep Technol Assess (Summ)*(119), 1-8. doi:10.1037/e439372005-001
- Gjerdingen, D., Crow, S., McGovern, P., Miner, M., & Center, B. (2009). Postpartum depression screening at well-child visits: validity of a 2-question screen and the PHQ-9. *Ann Fam Med*, 7(1), 63-70. doi:10.1370/afm.933

- Government Accountability Office. (2002). Anthrax Vaccine: GAO's Survey of Guard and Reserve Pilots and Aircrew (GAO-02-445). Washington, DC. Retrieved from http://www.gao.gov/products/gao-02-445
- Government Accountability Office. (2010). Afghanistan and Iraq: DoD should improve adherence to its guidance on open pit burning and solid waste management (GAO-11-63). Washington, DC. Retrieved from http://www.gao.gov/products/gao-11-63
- Government Accountability Office. (2015). Defense Health Care: DoD needs to clarify policies related to occupational and environmental health surveillance and monitor risk mitigation activities (GAO-15-487). Washington, DC. Retrieved from http://www.gao.gov/products/gao-15-487
- Hobson, C. J., Kamen, J., Szostek, J., Nethercut, C. M., Tiedmann, J. W., & Wojnarowicz, S. (1998). Stressful life events: A revision and update of the Social Readjustment Rating Scale. *Int J Stress Manag*, 5(1), 1-23. doi:10.1023/A:1022978019315
- Institute of Medicine. (2010). Returning Home from Iraq and Afghanistan: Preliminary Assessment of Readjustment Needs of Veterans, Service Members, and Their Families. Washington, DC.
- Ippolito, A. C., Seelig, A. D., Powell, T. M., Conlin, A. M. S., Crum-Cianflone, N. F., Lemus, H., . . . LeardMann, C. A. (2017). Risk Factors Associated with Miscarriage and Impaired Fecundity among United States Servicewomen during the Recent Conflicts in Iraq and Afghanistan. *Womens Health Issues*, 27(3), 356-365. doi:10.1016/j.whi.2016.12.012
- Khodr, Z. G., Bukowinski, A. T., Hall, C., Gumbs, G. R., Wells, N. Y., & Conlin, A. M. S. (2018). The Department of Defense Birth and Infant Health Research Program: Assessing the Reproductive Health of U.S. Active-Duty Women. *Semin Reprod Med*, 36(06), 351-360. doi:10.1055/s-0039-1678751
- Madhappan, B., Kempuraj, D., Christodoulou, S., Tsapikidis, S., Boucher, W., Karagiannis, V., . . Theoharides, T. C. (2003). High levels of intrauterine corticotropin-releasing hormone, urocortin, tryptase, and interleukin-8 in spontaneous abortions. *Endocrinology*, 144(6), 2285-2290. doi:10.1210/en.2003-0063
- MedlinePlus. (2020, March 04). Miscarriage. https://medlineplus.gov/ency/article/001488.htm
- Nakamura, K., Sheps, S., & Arck, P. C. (2008). Stress and reproductive failure: past notions, present insights and future directions. *J Assist Reprod Genet*, 25(2-3), 47-62. doi:10.1007/s10815-008-9206-5
- National Institute of Mental Health. (2019). Major Depression. Retrived from https://www.nimh.nih.gov/health/statistics/major-depression.shtml

- Nguyen, S., Leardmann, C. A., Smith, B., Conlin, A. M., Slymen, D. J., Hooper, T. I., . . . Millennium Cohort Study, T. (2013). Is military deployment a risk factor for maternal depression? *J Womens Health*, 22(1), 9-18. doi:10.1089/jwh.2012.3606
- O'Hara, M. W., & McCabe, J. E. (2013). Postpartum depression: current status and future directions. *Annu Rev Clin Psychol*, *9*, 379-407. doi:10.1146/annurev-clinpsy-050212-185612
- Peindl, K. S., Wisner, K. L., & Hanusa, B. H. (2004). Identifying depression in the first postpartum year: guidelines for office-based screening and referral. *J Affect Disord*, 80(1), 37-44. doi:10.1016/S0165-0327(03)00052-1
- Ryan, M. A., Pershyn-Kisor, M. A., Honner, W. K., Smith, T. C., Reed, R. J., & Gray, G. C. (2001). The Department of Defense Birth Defects Registry: overview of a new surveillance system. *Teratology*, 64 Suppl 1, S26-29. doi:10.1002/tera.1081
- Smith, T. C. (2009). The US Department of Defense Millennium Cohort Study: career span and beyond longitudinal follow-up. *J Occup Environ Med*, *51*(10), 1193-1201. doi:10.1097/JOM.0b013e3181b73146
- United States. (1999). Strom Thurmond National Defense Authorization Act for Fiscal Year 1999: Conference report. Washington, DC: U.S. G.P.O.
- Wells, T. S., LeardMann, C. A., Fortuna, S. O., Smith, B., Smith, T. C., Ryan, M. A., . . . Millennium Cohort Study. (2010). A prospective study of depression following combat deployment in support of the wars in Iraq and Afghanistan. *Am J Public Health*, 100(1), 90-99. doi:10.2105/AJPH.2008.155432
- World Health Organization. (2020). *Reproductive health*. https://www.who.int/westernpacific/health-topics/reproductive-health

APPENDICES

Appendix A: Glossary

Combat Experience: Endorsement of one or more of the following survey questions about being personally exposed: person's death due to war, disaster, or tragic event; physical abuse; dead or decomposing bodies; maimed soldiers or civilians; or prisoners of war or refugees.

Cumulative deployment length: The total number of days deployed in support of the operations in Iraq and Afghanistan during the 3-year period before the follow-up survey date, categorized as 0, 1-180, and more than 180 days. Deployment dates in and out of theater were obtained from the Contingency Tracking System of DMDC.

Deployed with combat: Deployed in support of the operations in Iraq and Afghanistan and reported combat experience (defined above). Deployment dates in and out of theater were obtained from the Contingency Tracking System of DMDC.

Deployed without combat: Deployed in support of the operations in Iraq and Afghanistan and did not report combat experience (defined above). Deployment dates in and out of theater were obtained from the Contingency Tracking System of DMDC.

Deployment experience: Categorized as nondeployed, deployed without combat, and deployed with combat in support of the operations in Iraq and Afghanistan.

Fecundity: Ability to produce offspring.

Infertility: The failure to achieve a pregnancy after 12 months or more of regular unprotected sexual intercourse. Using electronic medical encounter data, infertility was determined by the ICD-9-CM diagnostic codes 628.x.

Life stressors: Indication on the survey of having experienced: divorce or marital separation; major financial problems (including bankruptcy); forced sexual relations or sexual assault; sexual harassment; violent assault; a family member or loved one become severely ill or die; disabling illness or injury. Life stressors were classified as low/mild or moderate/major based on a modified version of the Social Readjustment Rating Scale scoring system.

Maternal depression: The nine depression items from the PHQ (PHQ-9) using the simple scoring method were used to define maternal depression among women who experienced childbirth. Items include: little interest or pleasure in doing things; feeling down, depressed, or hopeless; trouble falling or staying asleep; feeling tired or having little energy; poor appetite or overeating; feeling bad about yourself, or that you are a failure or have let yourself or your family down; trouble concentrating on things, such as reading the newspaper or watching television; moving or speaking so slowly that other people could have noticed or the opposite – being so fidgety or restless that you have been moving around a lot more than usual; thoughts that you would be better off dead or of hurting yourself in some way. Participants rate the

severity of depressive symptoms from not at all to nearly every day during the last 2 weeks. The simple scoring method sums the total score, with not at all = 0 and nearly every day = 3 points. A score of 0-9 is classified as no depression, and a score of \geq 10 is classified as having maternal depression.

Miscarriage: The spontaneous loss of a fetus before the 20th week of pregnancy. Self-reported miscarriage was defined by an affirmative report to the question: Have you had a miscarriage within the last 3 years. Using medical encounter data from the MDR, miscarriage was defined using the following ICD-9-CM diagnostic codes that indicate a pregnancy loss (630.xx-639.xx, 656.4x, V27.[1,3,4,6,7]), or procedure (66.62, 68.0, 74.3), or Current Procedural Terminology codes (59100, 59120, 59121, 59130, 59135, 59136, 59140, 59150, 59151, 59870).

Nondeployed: Not deployed in support of the operations in Iraq and Afghanistan during the period of study, indicated by deployment dates in and out of theater from the Contingency Tracking System of DMDC.

Reproductive health: Reproductive health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, in all matters relating to the reproductive system and to its functions and processes (World Health Organization, 2020).

Self-perceived impaired fecundity: Inability to produce offspring with no defined time period of regular unprotected sexual intercourse to become pregnant. Assessed by an affirmative report to the question: During the last 3 years have you tried and been unable to become pregnant.

Singleton infant: A child born as a single birth, in contrast to one that is part of a multiple birth.

TRICARE: The health care program for Service members, retirees, and their families.

Appendix B: List of Acronyms

BIHR	Birth and Infant Health Research
DMDC	Defense Manpower Data Center
DoD	Department of Defense
FY	Fiscal Year
GAO	Government Accountability Office
ICD	International Classification of Diseases
MDR	Military Health System Data Repository
NDAA	National Defense Authorization Act
NHRC	Naval Health Research Center
OMB	Office of Management and Budget
PHQ	Patient Health Questionnaire
RCS	Report Control Symbol
VA	Department of Veterans Affairs