



Women Veterans

Risk Factors Associated with Miscarriage and Impaired Fecundity among United States Servicewomen during the Recent Conflicts in Iraq and Afghanistan



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ABSTRACT

Background: Research on the reproductive health of U.S. servicewomen deployed in support of the recent operations in Iraq and Afghanistan is sparse. The objective of this study was to evaluate whether military experiences, including combat deployment, deployment length, and life stressors during the recent conflicts, were associated with increased odds for miscarriage or impaired fecundity among U.S. servicewomen.

Methods: We used data from the Millennium Cohort Study, a large longitudinal military study that began in 2001 and includes military personnel from all service branches, including active duty and Reserve/National Guard personnel. Participants for this study included women aged 18 to 45 years who had completed two questionnaires (2004–2006 and 2007–2008). Separate multivariable logistic regression models were performed to estimate the odds of reporting miscarriage and impaired fecundity by military experiences that adjusted for covariates. Subanalyses were conducted using *International Classification of Diseases, Ninth Revision, Clinical Modification* codes found in the Military Health System Data Repository for both outcomes among servicewomen on active duty.

Results: Overall, 31% and 11% of military servicewomen reported miscarriage and impaired fecundity, respectively, during the approximate 3-year follow-up period. After adjusting for demographic, behavioral, and military characteristics, deployment experiences and life stressors were not associated with miscarriage or perceived impaired fecundity. Subanalyses using medical record data confirmed these results.

Conclusions: Overall, these results suggest that military deployments do not increase risk for miscarriage and impaired fecundity among U.S. servicewomen. However, because the point estimates for many of the exposures were elevated, more research is needed to better understand the potential risks associated with environmental exposures and specific types of combat exposures.

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Women account for 14.6% of the U.S. Armed Forces, with more than 200,000 women deploying in support of the recent conflicts in Iraq and Afghanistan (“[Women in Military Service for America Memorial Foundation Inc.](#),” 2010). Before these conflicts, the number of women who deployed was much smaller, and women servicemembers often served in noncombat roles (“[Iraq and Afghanistan Veterans of America](#),” 2009). However, during the recent conflicts, servicewomen have reported in-theater combat experiences. This is in part due to the absence of traditional battle lines (Vogt et al., 2011) as well as recent policy changes allowing women to take on a wider range of duties, including infantry roles on combat teams, thereby increasing their exposures to combat and intense stress (Joint Chiefs of Staff, 2013). With an increasing number of servicewomen deploying and experiencing combat, there is a growing need to evaluate if these experiences adversely affect reproductive health (“[Iraq and Afghanistan Veterans of America](#),” 2009).

Deployments to the recent conflicts in Iraq and Afghanistan may have exposed women to both military-unique experiences as well as traditional factors associated with miscarriage and/or infertility. One known factor that has been associated with miscarriage and infertility is stress. The exact biological mechanism for which stress is believed to cause these adverse outcomes has not been confirmed, but the literature suggests that the immune and hormone alterations caused by stress may lead to reproductive failure (Agarwal, Aponte-Mellado, Premkumar, Shaman, & Gupta, 2012; Madhappan et al., 2003; Nakamura, Sheps, & Arck, 2008). Given that research in nonmilitary populations indicates that experiencing life stressors has an adverse effect on reproductive outcomes, it is important to determine if the unique stressors of military deployments are associated with adverse reproductive outcomes, such as miscarriage and impaired fecundity.

Previous research investigating the association of deployment with miscarriage and impaired fecundity among U.S. servicewomen is sparse and most of this research has focused on veterans (Araneta et al., 2004; [Armed Forces Health Surveillance Center](#), 2012; Doyle et al., 2004; Doyle, Maconochie, & Ryan, 2006; Kang et al., 2001; Katon et al., 2014; Mattocks et al., 2015; Wells et al., 2006). The majority of the miscarriage studies did not find an association of deployment to the 1991 Gulf War with miscarriage in pregnancies conceived after the war by women veterans (Doyle et al., 2004; Doyle et al., 2006; Kang et al., 2001; Wells et al., 2006). Although infertility among servicemembers and veterans who deployed in support of the operations in Iraq and Afghanistan has been studied, to our knowledge, only one previous report examined infertility among the current era of U.S. servicewomen ([Armed Forces Health Surveillance Center](#), 2012). Two of the previous studies described the prevalence of infertility (~2% have received a diagnosis of infertility, 16% reported history of infertility) among women veterans who received care at a VA facility, although neither study reported the effects of specific deployment related-stressor (Katon et al., 2014; Mattocks et al., 2015). One previous report found longer duration of deployment associated with an increased risk for infertility ([Armed Forces Health Surveillance Center](#), 2012). Moreover, the majority of these previous studies were limited by being cross-sectional or data linkage studies.

Exploring the relationship of recent deployments and combat-related experiences with miscarriage and impaired fecundity may help to better understand whether serving in the military has a negative effect on women's reproductive health.

Our longitudinal study aimed to evaluate if U.S. military servicewomen who deployed and experienced combat during the recent conflicts in Iraq and Afghanistan subsequently experienced an increased odds of miscarriage or impaired fecundity. The Millennium Cohort Study, as the largest longitudinal military study in U.S. history, has the unique ability to prospectively investigate women's reproductive health in relation to military experiences.

Material and Methods

Study Population and Data Sources

The study population was derived from the Millennium Cohort Study, a longitudinal study designed to evaluate the impact of military service on the long-term health of U.S. servicemembers. Using an in-depth questionnaire, military, health, occupational factors, and life experiences were assessed prospectively at 3-year intervals. The methodology of the Millennium Cohort Study has been described previously (Ryan et al., 2007; [Smith & Millennium Cohort Study](#), 2009). The study currently includes more than 200,000 participants who enrolled during four separate cycles between 2001 and 2013.

The population for the current study consisted of women from the first two enrollment cycles, or panels, who completed surveys during the 2004 through 2006 and 2007 through 2008 survey cycles. To be eligible, women had to be aged 18 to 45 years and to not have separated from the military before September 2001 ($n = 14,480$). After exclusion criteria, 3,366 women were included in the miscarriage analysis and 11,183 were included in the impaired fecundity analysis (Figure 1). The population for each outcome was stratified by panel owing to differing enrollment criteria. Exposures and covariates were measured on the 2004 through 2006 questionnaire, while outcomes were measured on the 2007 through 2008 questionnaire; therefore, for these analyses, the data collected from 2004 through 2006 are called baseline and the data collected from 2007 through 2008 are called follow-up (Figure 2).

Data sources included the Millennium Cohort Study questionnaire and electronic Department of Defense (DoD) personnel data provided by the Defense Manpower Data Center. The Millennium Cohort Study questionnaire was used to assess self-reported data, including information on self-reported miscarriage, self-perceived impaired fecundity, combat exposures, and other lifestyle and health metrics. Electronic personnel data from Defense Manpower Data Center was used to assess deployments in support of the recent operations in Iraq and Afghanistan, and military and demographic characteristics. The study was approved by the institutional review boards Naval Health Research Center and San Diego State University, and informed consent was obtained from all participants.

Outcomes

We assessed two outcomes using data from the Millennium Cohort Study questionnaire: self-reported miscarriage and self-perceived impaired fecundity. Miscarriage was assessed using the question, “Have you had a miscarriage within the last 3 years?” to which participants could respond, “Yes,” “No,” or “Does Not Apply,” on the follow-up questionnaire. Miscarriage was assessed among women who reported a pregnancy during the study time and had responded “Yes” or “No” to the miscarriage question.

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