Spousal Military Deployment during Pregnancy and Adverse Birth Outcomes

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Abstract

Background: Pregnant women with a spouse deployed in the military are at increased risk of depression and self-reported stress in comparison to those without a deployed spouse. In non-military populations, women who experience anxiety, depression, and stress during pregnancy face increased risk of adverse birth outcomes. This study aims to determine the association between a spouse's deployment and adverse birth outcomes in a military population.
Methods: We conducted a retrospective cohort study at Madigan Army Medical Center (MAMC) that examined birth records of all singleton deliveries to dependent spouses from September 2001-September 2011. Logistic regression was used to estimate relative risks and 95% confidence intervals (CI) of the associations between deployment and low birthweight (LBW, <2500g), preterm delivery (PTD, <37 weeks), small for gestational age (SGA, <10 percentile for gestational age), and Cesarean delivery.
Results: We identified 14,799 births at MAMC; 1,939 (13.1%) women had a spouse deployed at time of delivery. We found women with spouses in branches of service other than the Army (Air Force, Navy, Marines, and Coast Guard) were at a 79% increased risk of LBW (95% CI 1.18-2.71) and a 75% increased risk of PTD (95% CI 1.19-2.57). Among women with two or more children, we observed a 49% increased risk of LBW (95% CI 1.04-2.13) and a 56% increased risk of SGA (95% CI 1.09-2.22). Women 30-34 years old were at a 48% (95% CI 1.02-2.17) increased risk of PTD, 81% increased risk of LBW (95% CI 1.18-2.77), and a 67% increased risk of SGA (5% CI 1.09-2.55). Women ≥35 were at a 79% increased risk of PTD (95% CI 1.11-2.88).
Conclusion: Further research should focus on the relationship between the timing of deployment and gestational age, social support and stress reduction during deployment, and differences between branches of service and military treatment facilities**.**

Introduction

In 2011, there were 1.4 million men and women serving in the United States Armed Forces[1]. Over the past decade, it has been well documented that combat deployments service members have profound effects on mental health[2,3,4]. The impact of deployment reaches further to include the families of these men and women. Spouses must cope with increased stress and loss of part of their daily support structure during deployments[5]. Women with husbands who are deployed have more frequent diagnoses of depressive disorders, sleep disorders, anxiety, acute stress reaction, and adjustment disorders compared to women with no spouse deployed[6].

The negative effects of the deployment of a spouse have also been studied among women who are pregnant. Women with deployed spouses during pregnancy are at a 2.8 fold increased risk of depression and 1.9 fold increased risk of self-reported stress in comparison to women that do not have deployed spouses [7–11]. This has been shown to be true at different stages during pregnancy and in the postpartum period[8,9]. In studies conducted in non-military populations, increased stress and depression during pregnancy has been associated with greater risk of a variety of adverse birth outcomes including low birth weight (LBW), preterm delivery (PTD), small for gestational age (SGA) and Cesarean delivery[12–15]. Lack of social support has also been identified as a risk factor for LBW and PTD[16]. In a small study of a primarily Navy population in 2006, Robrect et al. reported no association between deployment and these adverse birth outcomes [9]; however, no study has conducted a primary analysis of this association over the duration of the operations in Iraq (2003-2011) and Afghanistan (2001- present) in an Army population.

The goal of our study was to estimate the associations between a spouse's deployment at delivery and risk of LBW, PTD, SGA, and Cesarean delivery among all births to dependent spouses at Madigan Army Medical Center (MAMC), a joint Army-Air Force installation in the Pacific Northwest, where yearlong combat deployments have been a constant role of service members over the past decade. We hypothesized that increased stress and depression due to a spouse's deployment will result in adverse birth outcomes for women with a spouse deployed at delivery.

Methods

Study design and subjects

For this retrospective cohort study, we examined all birth records at MAMC between September 2001 and September 2011. MAMC is a large military treatment center serving personnel in the Pacific Northwest region. The medical center has 34 training programs, a level III Neonatal Intensive Care Unit, and performs over 200 deliveries per month. Records were compiled from MAMC's Essentris database, the Military Health Systems comprehensive inpatient health records. Demographic information regarding the sponsor's branch of service and active-duty status was retrieved from MAMC's Composite Health Care System, the military's outpatient records system.

Only dependent spouses, non- active duty spouses of military personnel, who delivered at MAMC during the study time frame, were included. Active duty women, dependent daughters, and spouses of Public Health Service (PHS) Officers were excluded as they were not at risk of having a spouse deployed at the time of delivery. Analysis was restricted to singleton births and women for whom there was no missing information on spouse deployment.

Study measures

Deployment of a spouse during pregnancy, the exposure of interest, was collected through a yes/no question asked at time of delivery and recorded in the Essentris database. Similarly, the outcomes of LBW, PTD, SGA and delivery type were reported in the Essentris database. LBW was defined as an infant birth weight below 2500 grams. PTD was defined as a delivery prior to 37 weeks gestation. The clinical estimate of gestational age was used in this analysis. Babies below the 10th percentile of weight for their gestational age and sex were classified as SGA. Finally, delivery type was classified into two categories: vaginal delivery and Cesarean delivery. Vaginal delivery included the use of forceps or vacuum.

Data Analysis

Descriptive analysis compared women who experienced a spousal deployment at the time of birth to those that did not on characteristics including maternal age at delivery, maternal race, parity, number of living children, adequacy of prenatal care, and enlisted or officer status of spouse. Maternal age was categorized as ≤20, 20-24, 25-29, 30-34, and 35+ years. Maternal race was divided into White, Black, Asian/Pacific Islander, and multiple races. We used the Kotelchuck Index to classify prenatal care as inadequate, intermediate, adequate, or adequate plus[17].

We assessed the association between spousal deployment at the time of delivery and risk of LBW, PTD, and SGA using logistic regression to estimate relative risks (RR) and 95% confidence intervals (CI), controlling for potential confounding. To determine the association between Cesarean delivery and spousal deployment we used Poisson regression with robust standard error estimates and adjustment for potential confounders[18]. This method was used because Cesarean delivery is not a rare outcome (>10%), therefore the odds ratio estimated using logistic regression does not well approximate the RR. We determined a priori to control for maternal age. We assessed additional confounding based on a 10% change in the risk estimates[19] and found no additional confounders among maternal characteristics of age, race, parity, gravidity, and living children and spouse's rank (officer or enlisted) and branch of service. Due to missing data health behaviors during pregnancy such as smoking and alcohol use and prenatal care adequacy were not evaluated as confounders. We performed stratified analyses to assess for effect modification by maternal age, maternal race, living children, spouse's rank, and branch of service (Army vs. other branch). Effect modification was found by maternal age, living children, and branch of service. All analyses used STATA version 11.0. The institutional review boards of Madigan Army Medical Center and the University of Washington approved this research.

Results

We identified 20,168 births at MAMC between September 2001 and September 2011. After excluding active duty women (N=3,627), dependent daughters (N=520), unknown relation to sponsor (N=8), spouses of PHS members (N=27), those with multiple births (N=424) and those without information on a spouse's deployment (N=739), we included 14,799 births in the analysis. At delivery 1,939 (13.1%) women had a spouse deployed.

Women with and without a spouse deployed at delivery had similar pregnancy histories (gravidity, parity, living children, prior abortions), alcohol and tobacco use during pregnancy, and infant sex (Table 1). Women in both groups were primarily White (69.8% among deployed v. 72.5% among not deployed) but women with a spouse deployed were more likely to be Black (7.9% v. 7.0%) or Asian/Pacific Islander (7.7% v. 6.0%). Spouses that were deployed were less likely to be Officers (8.7% vs. 12.7%). A higher proportion of spouses that were deployed were in the Army compared with other branches of service (87.4% v. 82.6%).

We found no evidence that women with a deployed spouse compared to women without a spouse deployed at the time of delivery were at greater risk of PTD (RR 1.14, 95% CI 0.97-1.34), LBW (RR 1.12, 95% CI 0.92-1.36) SGA (RR 1.16, 95% CI 0.97-1.4), or Cesarean delivery (RR 0.98, 95% CI 0.90-1.06).

The association between a spouse's deployment and adverse pregnancy outcomes was different depending on branch of service of the spouse, number of living children, and maternal age. We observed women with spouses in branches of service other than the Army (Air Force, Navy, Marines, and Coast Guard) to be at a 79% increased risk of LBW (95% CI 1.18-2.71) and a 75% increased risk of PTD (95% CI 1.19-2.57) when a spouse was deployed (Table 3). We found no association between deployment and adverse birth outcomes among women with spouses in the Army.

Among women who had two or more living children, we observed a 49% increased risk of LBW (95% CI 1.04-2.13) and a 56% increased risk of SGA (95% CI 1.09-2.22) if a spouse was deployed at the time of delivery compared to those that were not deployed (Table 4). No association between deployment and adverse outcomes was found in our analysis for women with no or one living child.

Finally, we identified maternal age as a modifier of the association between deployment and adverse birth outcomes. Women between 30 and 34 were at a 48% (95% CI 1.02-2.17) increased risk of PTD, 81% increased risk of LBW (95% CI 1.18-2.77), and a 67% increased risk of SGA ((5% CI 1.09-2.55). We also found that women 35 and older were at a 79% increased risk of PTD (95% CI 1.11-2.88). We observed no associations between deployment and adverse birth outcomes in the younger maternal age categories. No differences in the associations were observed by maternal race or rank of the spouse.

Discussion

Our study investigated the association between a spouse's military deployment at time of delivery and adverse birth outcomes, including, PTD, LBW, SGA, and Cesarean delivery at a large Army medical center in the Pacific Northwest, between 2001 and 2011. We found that women with a spouse who was not in the Army were at increased risk of LBW and PTD if a spouse was deployed at the time of delivery. Women with 2 or more living children had higher risk of LBW and SGA if a spouse was deployed. Finally, if a spouse was deployed at time of delivery, women between 30 and 34 years old were at higher risk of PTD, LBW, and SGA, and women 35 years and older were at increased risk of PTD. No association between deployment and adverse birth outcomes was observed in the overall population.

Our study found that women with a spouse who was not in the Army (Air Force, Navy, Marines, and Coast Guard) were at an increased risk of LBW and PTD if a spouse was deployed at time of delivery. In a study by Roberct et al. no association was found between deployment and adverse birth outcomes among a Navy population[9]. Their main finding was a 2.75-fold increased risk of a postpartum depression when a spouse was deployed. It is likely that differences in outcomes by branch of service in our study were due to MAMC's status as a referral hospital for Navy hospitals in the region. Women with spouses outside of the Army were likely to have delivered at MAMC due to referral for a high risk pregnancy that may have resulted in an adverse birth outcome. This is confirmed in our data that showed that among those women who did not have a spouse deployed at the time of delivery, those with spouses in other branches were almost twice as likely to have PTD (14.7% v. 8.1%) and LBW (10.1% v 5.6%) compared to women with a spouse in the Army.

We found women who had 2 or more living children were at higher risk of LBW and SGA when a spouse was deployed in comparison to those that did not have a spouse deployed at time of delivery. This is consistent with the findings by Haas et al. which found 2 or more children at home (vs. none) was associated with a 2.7-fold increased risk (95% CI 1.11-6.60) of self-reported stress[11]. In an earlier study,

they also reported a 2.3-fold increased risk of self-reported stress associated with any children at home[10]. With a spouse deployed, women become temporary single parents. In a study that examined changes in cohabitation among a non-military population, women who left cohabiting relationships with a child's father reported decreases in social support and increases in parental stress, maternal hardship, and depression[20]. Sepa et al. also identify lack of social support as a major factor in maternal parenting stress.[21] Young age of children has been linked with maternal stress in low income single family homes.[22] It could be this increased risk of depression that results in adverse birth outcomes among these women. A meta-analysis showed a 10% increased risk of LBW when comparing those with and without depression in the US (RR=1.10, 95% CI 1.01-1.21)[13]

Finally, we observed women who were 30-34 years old were at increased risk of LBW, PTD, and SGA and women 35 years and older were at increased risk of PTD when a spouse was deployed. This is inconsistent with both analyses conducted by Haas which found no increased risk of stress associated with maternal age[10,11]. Other studies conducted in military populations have not addressed maternal age in their analyses[8,9]. It is possible that older women might feel a greater sense of loss and mortality with a partner deployed compared with younger women. Another possibility is that older women are at increased risk of adverse birth outcomes due to chronic diseases such as hypertension and diabetes. We were unable to control for these conditions due to our data limitations. By not controlling for these factors, our results might be explained by residual confounding.

Our study had several limitations. Although potential confounders of smoking, alcohol use, and prenatal care adequacy were collected; due to large amounts of missing data we were unable to adequately adjust for confounding. It is unlikely, but possible, that this would have biased our estimates because although these variables are associated with the outcomes of interest, there is no reason to suppose that they would be associated with a spouse's risk of deployment. Future research should consider multiple imputation or a thorough record review to better collect and control for these potential confounders.

We measured deployment at the time of delivery whereas we would have preferred to measure deployment more precisely to include length, duration, and number of deployments in relation to timing in pregnancy, rather than just at delivery. It is possible that a spouse could have been deployed for the majority of the pregnancy but was stateside at time of delivery. Conversely, a spouse could have been stateside for the majority of the pregnancy but deployed shortly before the birth. Mansfield et al. showed cumulative time deployed is a significant predictor of mental health diagnoses of women and children with deployed spouses or parents[6,23]. A prior study at MAMC indicated that deployment during later stages of pregnancy was associated with an increase in depression[8]. A large Swedish study reported stress during 5 months of gestation or later was associated with higher risk of PTD, LBW, and SGA [24]. We conducted analysis by branch of service as a proxy indication of length and number of deployments in our analyses and found differences between the Army and other branches (Navy, Air force, Marines, Coast Guard). A more thorough adjustment, including timing of deployment in relation to gestational age of pregnancy, could be made through ascertainment of deployment history by linking these data to the Defense Manpower Data Center[25].

Finally, although we had information about all deliveries at MAMC within the study time frame, our results may have been affected by selection bias as we were unable to include pregnant women that were eligible to deliver at MAMC but did not for various reasons. This could include women who had a spouse deployed and chose to return to a parent or family member's home for the delivery. No research to date has focused on the motivation or the impact of families returning to "place of origin"

during lengthy combat deployments of service members. It is likely that these women represent a small proportion of the population and the effect on such a large population would be minimal. To quantify the magnitude of this potential effect, future research could ascertain military insurance records to determine number who return home, maternal age, and number of prior births.

Our study is also limited in generalizability. This study does not include National Guard or Reservists whose families receive different health care and resources compared with active duty personnel. MAMC is large training hospital serving a joint Army and Air Force base. It is unlikely that resources and care in more isolated bases would be similar to the specialty care that is available at MAMC. Finally, the population is largely Army spouses. It is possible that the differences in frequency, length, location, and danger of deployment between the branches of service are related to differential stress levels among spouses. Army deployments are longer than other branches[26] and the Army has suffered a greater proportion of casualties in the recent wars in comparison to its size than all other branches except for the Marines[27,28]. Therefore these results may not generalize to other branches of service.

Women with spouses in a branch of service other than the Army, with more than 2 children, or 30 or older were at higher risk of adverse birth outcomes when a spouse was deployed at delivery. These findings may help inform support programs, such as those assessed in randomized trials including, autogenic training to reduce anxiety during pregnancy and other mind-body interventions that may be effective at managing stress and anxiety during delivery and in the postpartum period[29]. This research will also help practitioners best serve women with deployed spouses within the military. Future research should focus on the relationship between the timing of deployment and gestational age, social support and stress reduction during deployment, and differences between branches of service and military treatment facilities.

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Table 1: Characteristics of Pregnant Dependent Spouses at Madigan Army Medical Center, September 2001- September 2011

	Spouse Deployed at Birth N=1939*		Spouse Not Deployed at Birth N=12860*	
	n	%	n	%
Maternal Age				
≤20	133	6.9	719	5.6
20-24	779	40.1	4778	37.2
25-29	586	30.3	4147	32.3
30-34	313	16.2	2188	17.0
35+	125	6.5	1010	7.9
Maternal Race				
White	1352	69.8	9317	72.5
Black	153	7.9	900	7.0
Asian/Pacific Islander	149	7.7	768	6.0
Multiple Race/Other	282	14.6	1859	14.5
Gravidity				
1	546	28.2	3891	30.3
2	578	30.0	3996	31.2
3	376	19.4	2471	19.3
≥4	434	22.4	2463	19.2
Parity				
0	740	39.7	5151	41.4
1	638	34.3	4460	35.8
2	332	17.8	1965	15.8
≥3	153	8.2	871	7.0
Living Children				
0	719	38.2	4895	39.3
1	650	34.5	4501	36.1
2	333	17.7	2065	16.6
3	132	7.0	686	5.5
≥4	49	2.6	304	2.5
Prior Preterm Births				
0	1568	90.3	10509	90.4
1	139	8.0	916	7.9
2+	30	1.7	199	1.7
Prior Abortions				
0	1180	65.6	8114	67.4
1	374	20.8	2550	21.2
2	155	8.6	872	7.2
≥3	90	5.0	508	4.2

Adequacy of prenatal care[a]				
Inadequate	44	4.7	300	5.0
Intermediate	246	26.4	1695	28.1
Adequate	506	54.3	2984	49.7
Adequate plus	136	14.6	1031	17.2
Maternal Height				
<63 inches (25th %tile)	489	26.3	3046	24.8
63-66 inches (25-75th %tile)	880	47.4	6206	50.6
>66 inches (75th%tile)	488	26.3	3023	24.6
Sex of Infant				
Male	890	48.8	5644	48.0
Female	933	51.2	6112	52.0
Alcohol Use[b]				
yes	38	4.2	210	3.4
no	877	95.8	6018	96.6
Tobacco Use[c]				
yes	56	6.3	319	5.2
no	767	86.6	5368	88.2
quit	63	7.1	402	6.6
Rank				
Enlisted	1365	87.5	9265	83.5
Officer	168	10.8	1638	14.8
Warrant Officer	27	1.7	184	1.7
Branch of Service				
Army	1364	87.4	9172	82.6
Air Force	77	5.0	1302	11.7
Navy	87	5.6	480	4.3
Marines	27	1.7	85	0.8
Coast Guard	5	0.3	64	0.6

*Numbers may not sum to totals due to missing data

a-7,857 observations missing

b-7656 observations missing

c-7824 observations missing

Table 2: Association Between Spouse's Deployment at Delivery and Adverse Birth Outcomes at Madigan Army Medical Center, September 2001-2011

	Deployed N=1939		Not deployed N=12860			
Outcomes	n	%	n	%	Crude RR (95% CI)	Adjusted RR* (95% CI)
Preterm delivery						
Yes	188	10.2	1049	9.1	1.13	1.14
No	1660	89.8	10453	90.9	(0.95-1.33)	(0.97-1.34)
Low birthweight						
Yes	123	7.0	725	6.4	1.11	1.12
No	1634	93.0	10671	93.6	(0.91-1.35)	(0.92-1.36)
Small for gestational age						
Yes	163	9.2	879	8.0	1.17	1.16
No	1609	90.8	10138	92.0	(0.98-1.40)	(0.97-1.4)
Delivery type						
Cesarean section	476	24.8	3296	25.8	0.96	0.98
Vaginal	1442	75.2	9479	74.2	(0.89-1.04)	(0.90-1.06)

*Adjusted for maternal age

Table 3: Association Between Spouse's Deployment at Delivery and Adverse Birth Outcomes by Branch at Madigan Army Medical Center, September 2001-2011

	Army					Other Branches				
	Deployed N=1364		Not deployed N=9172			Deployed N=196		Not deployed N=1931		
Outcomes	n	%	n	%	Adjusted RR* (95% CI)	n	%	n	%	Adjusted RR* (95% CI)
Preterm delivery										
Yes	111	8.5	656	8.1	0.99	39	22.2	248	14.7	1.75
No	1198	91.5	7486	91.9	(0.76-1.28)	137	77.8	1438	85.3	(1.19-2.57)
Low birthweight										
Yes	67	5.5	453	5.6	1.06	32	17.1	187	10.9	1.79
No	1154	94.5	7693	94.4	(0.86-1.31)	155	82.9	1522	89.1	(1.18-2.71)
Small for gestational age										
Yes	119	9.5	635	8.1	1.18	20	12.0	138	8.7	1.37
No	1135	90.5	7179	91.9	(0.96-1.45)	147	88.0	1448	91.3	(0.83-2.27)
Delivery type										
Cesarean section	340	25.2	2315	25.4	0.99	52	26.7	529	27.6	1.07
Vaginal	1011	74.8	6799	74.6	(0.87-1.13)	143	73.3	1388	72.4	(0.77-1.51)

*Adjusted for Maternal Age Categories

Table 4: Adjusted Association Between Spouse's Deployment at Delivery and Adverse Birth Outcomes by Living Children at Madigan Army Medical Center, September 2001-2011

	0 Living Children			1 Living Child			2+ Living Children		
	Deployed	Not deployed		Deployed	Not deployed		Deployed	Not deployed	
	N=719	N=4895		N=650	N=4501		N=514	N=3055	
Outcomes	%	%	Adjusted RR* (95% CI)	%	%	Adjusted RR* (95% CI)	%	%	Adjusted RR* (95% CI)
Preterm delivery									
Yes	10.8	9.7	1.15	8.3	7.9	1.07	11.8	10.0	1.22
No	89.2	90.3	(0.89-1.49)	91.7	92.1	(0.78-1.45)	88.2	90.0	(0.90-1.66)
Low birthweight									
Yes	7.6	7.5	1.04	4.8	5.0	0.95	9.2	6.4	1.49
No	92.4	92.5	(0.76-1.42)	95.2	95.0	(0.63-1.43)	90.8	93.6	(1.04-2.13)
Small for gestational age									
Yes	10.7	10.2	1.06	7.6	6.8	1.11	9.0	6.0	1.56
No	89.3	89.8	(0.81-1.38)	92.4	93.2	(0.80-1.55)	91.0	94.0	(1.10-2.22)
Delivery type									
Cesarean section	25.5	26.0	1.01	23.9	26.0	0.94	23.5	24.2	0.99
Vaginal	74.5	74.0	(0.88-1.15)	76.1	74.0	(0.81-1.08)	76.5	75.8	(0.83-1.17)

*Adjusted for maternal age categories

Table 5: Adjusted Association Between Spouse's Deployment at Delivery and Adverse Birth Outcomes by Maternal Age at Madigan Army Medical Center, September 2001-2011

	<20			**20-24**			**25-29**			**30-34**			**35+**		
	Deployed	Not deployed		Deployed	Not deployed		Deployed	Not deployed		Deployed	Not deployed		Deployed	Not deployed	
	N=133	N=719		N=779	N=4778		N=586	N=4147		N=313	N=2188		N=125	N=1010	
Outcomes	%	%	Adjusted RR* (95% CI)	%	%	Adjusted RR* (95% CI)	%	%	Adjusted RR* (95% CI)	%	%	Adjusted RR* (95% CI)	%	%	Adjusted RR* (95% CI)
Preterm delivery															
Yes	9.5	9.9	0.97 (0.50-1.85)	9.7	8.9	1.09 (0.84-1.42)	7.1	8.1	0.88 (0.62-1.23)	13.0	9.5	1.48 (1.02-2.17)	21.5	13.4	1.79 (1.11-2.88)
No	90.5	90.1		90.3	91.1		92.9	91.9		87.0	90.5		78.5	86.6	
Low birthweight															
Yes	7.6	7.2	1.08 (0.51-2.28)	5.4	6.3	0.85 (0.60-1.20)	6.5	5.5	1.19 (0.82.-1.74)	10.7	6.5	1.81 (1.18-2.77)	9.6	9.4	1.05 (0.53-2.05)
No	92.4	92.8		94.6	93.7		93.5	94.5		89.3	93.5		90.4	90.6	
Small for gestational age															
Yes	6.5	10.6	0.58 (0.27-1.25)	8.6	8.6	1.00 (0.75-1.33)	9.7	7.6	1.30 (0.95-1.77)	10.6	7.0	1.67 (1.09-2.55)	10.3	7.0	1.57 (0.81-3.04)
No	93.5	89.4		91.4	91.4		90.3	92.4		89.4	93.0		89.7	93.0	
Delivery type															
Cesarean section	27.3	20.4	1.32 (0.97-1.82)	21.7	22.1	0.98 (0.85-1.08)	23.6	25.8	0.91 (0.78-1.06)	27.6	29.9	0.89 (0.74-1.10)	40.8	37.9	1.10 (0.88-1.37)
Vaginal	72.7	79.6		78.3	77.9		76.4	74.2		72.4	70.1		59.2	62.1	

*Adjusted for living children and maternal age