

Conception and Pregnancy during the Persian Gulf War: The Risk to Women Veterans

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PURPOSE: To enumerate Gulf-War (GW) exposed conceptions and to compare reproductive outcomes of GW-exposed pregnancies with postwar conceptions of women Gulf War veterans (GWV) and women nondeployed veterans (NDV).

METHODS: Deployment data and inpatient records from 153 military hospitals identified servicewomen who were pregnant between August 1990 and May 1992 and belonged to military units that were deployed to the Gulf War. Postal surveys were used in 1997 and 1998 to elicit reproductive history; responses were validated against military hospitalization records. Reproductive outcomes of GW-exposed pregnancies were compared with postwar conceptions of women GWVs and NDVs.

RESULTS: 3285 women had a pregnancy-related admission; of these, 1558 completed the questionnaire. Self-reported reproductive outcomes and dates, gestational data, and individual deployment dates identified 415 Gulf War-exposed pregnancies, 298 GWV postwar conceptions, and 427 NDV conceptions. Compared with NDV conceptions, adverse reproductive outcomes were similar among GW-exposed pregnancies. However, spontaneous abortions [NDV: 9.1%, GWV postwar: 22.8%, adjusted odds ratio (OR) = 2.92, 95% confidence interval (CI): 1.9, 4.6] and ectopic pregnancies (NDV: 1.4%, GWV postwar: 10.7%, adjusted OR = 7.70, 95% CI, 3.0, 20) were elevated for GWV postwar conceptions.

CONCLUSION: GW-exposed conceptions and nondeployed conceptions had similar outcomes. However, GWV postwar conceptions were at increased risk for ectopic pregnancies and spontaneous abortions. *Ann Epidemiol* 2004;14:109–116. © 2003 Elsevier Inc. All rights reserved.

KEY WORDS: Ectopic Pregnancy, Fetal Death, Gulf War, Military Personnel, Spontaneous Abortion, Servicewomen.

INTRODUCTION

Adverse reproductive outcomes have been reported among American and Canadian Gulf War veterans (GWV) including miscarriage, birth defects, and sexual dysfunction (1–4). The US General Accounting Office identified 21 potential reproductive toxicants and teratogens that were present

during the Gulf War (GW) (5). These include agents present in oil fires and soil samples (arsenic, benzene, benzo-pyrene, cadmium, lead, mercury, nickel, toluene, xylene, di-n-butyl phthalate, hexachlorobenzene, hexachloroethane, pentachlorophenol, hexachlorocyclopentadiene) pesticides (carbaryl, diazinon, dichlorvos, ethanol, lindane, warfarin) and decontaminating agents (ethylene glycol monomethyl ether) (5).

The Gulf War represented the largest deployment of women in US history. Between August 2, 1990 and July 31, 1991, a total of 49,973 women were deployed to the Gulf War. However, information on their reproductive outcomes is scarce. Published reports described 104 pregnancies that were either conceived or gestating in the Gulf War environment (6–9), although some estimates predict as many as 900 Gulf War-exposed pregnancies (6). Evacuation hospitals and support battalion medical units reported pregnancy rates of 1.8% to 2.2% among women presenting for care during the Gulf War (6, 7). Pregnancy testing was the most common reason for seeking gynecologic care (6), and pregnancy was the most common reason for evacuating female soldiers from the Gulf War theater (8).

These expectant women and their unborn children may have been more susceptible to reproductive toxins,

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Selected Abbreviations and Acronyms

CI = confidence interval
DMDC = Defense Manpower Data Center
GWV = Gulf War veteran
NDV = nondeployed veteran
OR = odds ratio
US = United States

teratogens, vaccinations, medications, and occupational stressors (10–18). Exposure to solvents and fuels has been associated with reduced levels of reproductive hormones among Air Force personnel (17). Additionally, clinically recognized spontaneous abortions were elevated among Army women who were deployed to Somalia, and used malaria chemoprophylaxis while unaware of their pregnancy (18).

The objectives of this study were to: a) enumerate pregnancies that occurred or were gestating in the Gulf War, b) characterize reproductive outcomes among Gulf War-exposed conceptions, and c) compare reproductive outcomes of GW-exposed pregnancies with postwar conceptions of GWV women, and conceptions of nondeployed veteran (NDV) women who belonged to deployed military units.

METHODS

Study Population

The Defense Manpower Data Center (DMDC) in Seaside, California maintains demographic, manpower, deployment, and hospitalization data on US military personnel. Data included records from 579,931 GWVs who were on active duty as of February 1, 1991, the peak of the Gulf War. Dates of deployment to and return from the Gulf War theater, unit identification code, and military occupation were obtained from DMDC. However, such data recorded the deployment dates of each military unit, rather than individual deployment dates of each servicemember. Misclassification of deployment status may have occurred among women who were pregnant during the Gulf War since deployment orders may have been cancelled or delayed for pregnant women.

Military hospital discharge data were used to identify women who belonged to military units but were admitted for pregnancy-related diagnoses between August 2, 1990, and May 31, 1992. Hospital admission and unit deployment dates were used to identify possible Gulf War-exposed pregnancies with discharge diagnostic codes of: 1) a livebirth or stillbirth (International Classification of Disease (ICD)-9-CM codes V27.0–V27.7) (19) while a) the military unit was deployed to the Gulf War or b) ≤ 41 weeks after the unit returned from deployment; 2) spontaneous abortions, induced abortions, or ectopic pregnancies (ICD-9-CM

codes 630–638), occurring while a) the unit was deployed or b) ≤ 22 weeks upon return; and 3) pregnancy-related complications (ICD-9-CM codes 640–676) including antepartum hemorrhage, placenta previa, pre-eclampsia, and early or threatened labor, while the military unit was deployed.

A self-administered questionnaire was mailed in 1997 and 1998 to determine deployment history, individual deployment dates, and reproductive outcomes, including dates of delivery or fetal loss, gestational age, and birth weight. Written, informed consent was obtained from all survey participants. Survey responses were based on recall, or consultation with birth certificates, diaries, or copies of medical records and military personnel records. Discharge diagnostic data were retrieved from military hospitals to validate self-reported reproductive outcomes.

Case Criteria

Data from completed surveys were reviewed; GW-exposed pregnancies were defined as livebirths, stillbirths, spontaneous or induced abortions, or ectopic pregnancies where a) birth or fetal loss occurred while the servicewoman was reportedly deployed to the Gulf War, or b) the interval between the date returned from deployment and date of birth or fetal loss was less than the self-reported gestational age, minus 2 weeks. To account for errors in gestational age estimation and differences in ascertainment methods of gestational age, 2 weeks was subtracted from the reported gestational age for a conservative estimate of GW-exposed pregnancies. The period of conception could not be estimated for births or fetal losses with missing self-reported maternal deployment dates or gestational age.

GW-exposed pregnancies were stratified to distinguish conceptions conceived prior to deployment but were gestating in the Gulf War theater (predeployment conceptions) from conceptions that occurred in the Gulf War theater (in-theater conceptions). Predeployment conceptions were defined as births or fetal losses where the interval between the dates of deployment and birth or fetal loss was less than the reported gestational age. In-theater conceptions included outcomes where the interval between the dates of return and birth or fetal loss was less than the reported gestational age.

Many respondents were never deployed to the Gulf War, but belonged to deployed units. These NDV women were likely excluded from deployment because of pregnancy, or their skills were needed elsewhere. Other women returned from the war earlier than their unit's return date and had postwar conceptions. Data from these GWVs with postwar conceptions and NDVs were used as internal comparison groups against GW-exposed pregnancies. GWV postwar conceptions included those where the interval between the mother's self-reported dates of return and birth or fetal

loss was greater than the reported gestational age. NDV conceptions were defined as those occurring between August 1990 and May 1992 to servicewomen who reported never having been deployed to the Gulf War.

Statistical Analysis

The prevalence of stillbirths, spontaneous abortions, induced abortions, and ectopic pregnancies were calculated per total number of reported pregnancies. Student's *t* tests, ANOVA, chi-square tests, and multivariable analysis were performed, using SAS (Version 6, Cary, NC). Statistical significance was designated at $p < 0.05$ or 95% confidence intervals (CI) which excluded 1.

RESULTS

Hospitalization data from 153 US military facilities throughout the world identified a total of 3825 women, classified as GWVs (by DMDC), with pregnancy-related admissions between August 2, 1990 and May 31, 1992. Based on unit deployment dates and hospitalization dates, a total of 867 women gave birth or experienced a fetal loss while their units were deployed to the Gulf War; 852 women were admitted for other pregnancy-related diagnoses, and 2106 women had a livebirth or stillbirth ≤ 41 weeks, or a fetal loss ≤ 22 weeks after their units returned from deployment. Some women in the latter group may not have had GW-exposed pregnancies, but had postwar conceptions if they conceived immediately after their return and had short gestations.

A total of 3105 (81%) women presumably received the survey; 1558 (50%) completed the questionnaire. Of the remaining women, 1443 likely received the survey (their surveys were not returned by the postal service as undelivered), but did not respond; 102 women were not eligible or indicated their preference not to participate, and 2 were deceased.

Among the 1558 survey participants, 208 had incomplete or insufficient data, while 135 GWVs reported having a birth or fetal loss before deployment. A total of 514 women reported not having served in the Gulf War; of these, 105 NDV women had reproductive outcomes outside of the study period dates. Of the remaining 1110 respondents, 409 were self-reported NDVs, while 701 women reported having served in the Gulf War; self-reported individual dates of deployment, dates of birth or fetal loss, and gestational age suggest an estimated 409 women had Gulf War-exposed pregnancies, and 292 GWVs had postwar conceptions.

Individual deployment dates (based on survey responses) differed from unit return dates (by DMDC records) for many

participants. Although selection of the initial cohort included births occurring < 41 weeks after the military unit returned from the Gulf war; many women returned earlier than their units, such that, births included those occurring < 70 weeks after the mother's self-reported date of return from deployment.

Participants were more likely to be older (≥ 25 years of age when deployed, participants: 50.6% vs. nonparticipants: 40.8%), white (53.4% vs. nonwhite: 39.4%), married (55.8% vs. unmarried: 47.1%), members of the Marine Corps or Air Force (15.0% vs. Army or Navy: 10.6%), were either petty officers or military officers (16.5% vs. enlisted personnel: 7.4%) and more likely to have remained on active duty (36.1% vs. reservists: 27.9%) than nonparticipants (data not shown).

During the Gulf War, women with GW-exposed pregnancies were significantly younger (mean age, 24.2 years) than GWVs with postwar conceptions (26.4 years) and NDVs (25.0 years), and were more likely to be unmarried, of junior enlisted rank (E1 to E3 paygrade), served in the Air Force, and less likely to have a college degree compared with NDVs (Table 1). GWVs with postwar conceptions were more likely to be older and to have served in the Air Force compared with NDV women (Table 1). No differences were observed among the 3 groups with respect to race, military occupation, reproductive history, and proportion that separated from the military.

Six of the 409 women with GW-exposed conceptions were pregnant twice while deployed to the Gulf War, for a total of 415 GW-exposed conceptions. Six of the 292 GWV women with postwar conceptions were multiparous between their return from deployment and the end of the study period, for a total of 298 GWV postwar conceptions. Eighteen of the 409 NDV women conceived twice during the study period, for a total of 427 NDV conceptions.

Reproductive outcomes varied significantly by maternal deployment category (Table 2). GWV postwar conceptions were less likely to result in a livebirth (64%) compared with NDV (86%) and Gulf War-exposed conceptions (84%, Table 2, p -value = 0.001). Stillbirths were more frequent among NDV conceptions (2.3%) compared with GW-exposed conceptions (0.2%) and GWV postwar conceptions (0.7%, $p = 0.011$). Spontaneous abortions were more frequent among GWV postwar conceptions (22.8%) compared with NDV conceptions (9.1%) and GWV exposed conceptions (11.6%, $p = 0.001$). Similarly, ectopic pregnancies were more common among GWV postwar conceptions (10.7%) than NDV (1.4%) or GW-exposed (2.4%) conceptions ($p = 0.001$). Reported induced abortions did not vary by deployment category.

Discharge diagnostic data from military hospitals were compared with self-reported reproductive outcomes. Five (39%) of the 13 self-reported stillbirths and 117 (75%) of

TABLE 1. Demographic, military, and reproductive characteristics among US women military personnel, by Gulf War deployment and conception category, August 1990 to May 1992

Characteristics	Nondeployed veterans' conception (n = 409)%	Gulf War-exposed conception (n = 409)%	Gulf War veteran postwar conception (n = 292)%
Age group (years), Feb. 1991			
≤19	5.1	3.9	0
20–24	48.4	55.5	41.1
25–29	30.6	29.8	36.6
≥30	15.9	10.8*	22.3
Race/Ethnicity			
White	52.1	48.7	45.2
Black	33.7	36.4	40.8
Other	13.7	14.2	13.4
Not available	0.5	0.7	0.6
Marital status, 1991			
Single	33.3	49.6*	36.6
Married	59.4	44.8*	57.2
Divorced/widowed	4.6	4.9	5.5
Not available	2.7	0.7	0.7
Branch of service			
Army	76.5	74.8	72.9
Navy	7.8	11.2	8.9
Marine Corps	12.5	4.9*	6.9**
Air Force	3.2	9.1*	11.3**
Military paygrade, 1991			
Junior enlisted, E1-E3	30.3	37.2*	25.7
Senior enlisted, E4-E5	50.6	48.7	54.4
Petty officer, E6-E8	8.6	7.1	8.9
Officer (WO1-WO4, O1-O10)	10.5	6.8	11.0
Not available	0	0.2	0
Military service, 1997–1998			
Separated	65.8	66.5	65.4
Active duty	34.2	33.5	34.6
Education, 1991			
High school	82.4	88.5	82.2
College	17.6	11.5*	16.8
Not available	0	0	1.0
Military occupation, 1991			
Seamanship specialist	2.1	4.3	1.7
Electrical equipment repair	3.5	2.7	2.4
Communication	14.7	15.2	12.4
Healthcare specialist	9.1	9.6	7.7
Other tech specialist	3.5	4.1	3.7
Administrative support	32.2	26.5	29.5
Electrical-mechanical/equipment repair	12.2	12.3	16.8
Tradesman and craftsman	3.3	3.1	4.0
Service and supply	16.4	19.0	18.1
Trainees and patients	0.7	1.2	1.7
Not available	2.3	1.9	2.0
Reproductive history			
Nulliparous	50.6	52.3	44.5
Previous stillbirth [†]	1.0	0	0.6
Previous miscarriage [†]	24.3	28.2	24.7
Previous ectopic pregnancy [†]	2.0	2.6	4.9

* $p < 0.05$ (Gulf War-exposed vs. nondeployed), chi-square analysis.

** $p < 0.05$ (Gulf War veteran postwar vs. nondeployed), chi-square analysis.

[†]Previous pregnancy.

the 155 self-reported spontaneous abortions were confirmed against military hospitalization records. Nine of 48 spontaneous abortions among GW-exposed conceptions could not be validated since they occurred in medical military tents

in the Gulf War theater. Forty-three of the 48 (90%) self-reported ectopic pregnancies were concordant with military hospitalization data. Induced abortions are not routinely performed in military facilities unless medically indicated.

TABLE 2. Reproductive outcomes among US women military personnel, by Gulf War deployment and conception category, August 1990 to May 1992

	Nondeployed veterans' conception (n = 427)		Gulf War-exposed conception (n = 415)		Gulf War veteran postwar conception (n = 298)		p-value
	No.	%	No.	%	No.	%	
Livebirth	367	85.8	350	84.3	192	64.4	0.001
Stillbirth	10	2.3	1	0.2	2	0.7	0.011
Spontaneous abortion	39	9.1	48	11.6	68	22.8	0.001
Ectopic pregnancy	6	1.4	10	2.4	32	10.7	0.001
Induced abortion	5	1.2	6	1.4	4	1.3	0.938

Only one of the 15 induced abortions was performed in a military hospital; the remaining 14 abortions likely occurred in nonmilitary facilities and could not be validated.

Compared with NDV conceptions, GW-exposed conceptions had a higher risk of spontaneous abortions, but the difference was marginally significant (adjusted odds ratio (OR) = 1.44, 95% CI, 0.9, 2.3) (Table 3). GWV postwar conceptions had a three-fold risk of spontaneous abortions (adjusted OR = 2.92, 95% CI, 1.9, 4.6) compared with NDV conceptions, even after adjusting for previous miscarriage, demographic characteristics, and military covariates.

Ectopic pregnancies were few among NDV and GW-exposed conceptions, and the adjusted risk did not differ (adjusted OR = 1.91, 95% CI, 0.7, 5.5). However, among GWV postwar conceptions, the adjusted risk of ectopic pregnancy was nearly 8 times higher (adjusted OR = 7.70, 95% CI, 3.0, 19.8) compared with NDV conceptions; this persisted after adjusting for reproductive history, and demographic and military characteristics.

Among the 415 GW-exposed pregnancies, 88 (21%) were estimated to be pre-deployment conceptions but were gestating in the war environment; they were at the early stages of gestation (mean: 4.7 weeks) when deployed. The

remaining 327 (79%) were estimated to be in-theater conceptions (Table 4). Women with predeployment and in-theater conceptions did not differ with respect to age, education, marital status, branch of service, military rank, or reproductive history, although women with predeployment conceptions were more likely to be white ($p = 0.002$, data not shown). Reproductive outcomes did not differ among in-theater and predeployment conceptions (Table 4), even after adjusting for reproductive history and demographic and military characteristics (data not shown).

DISCUSSION

This investigation represents the first epidemiologic study to characterize reproductive outcomes among women who were pregnant while serving in the Gulf War. One-third of our survey respondents who provided complete data had a Gulf War-exposed pregnancy. Assuming that 1/3 of nonparticipants and survey respondents with incomplete data also had Gulf War-exposed pregnancies, an additional 580 GW-exposed pregnancies might be expected. Thus, a total of

TABLE 3. Multivariate-adjusted odds ratios of fetal loss: Gulf War-exposed and postwar conceptions compared with nondeployed veterans' conceptions, US women military personnel, August 1990 to May 1992

	Gulf War-exposed conception		Gulf War Veteran postwar conception	
	Odds ratio*	95% confidence interval	Odds ratio*	95% confidence interval
Spontaneous abortion		(n = 48)		(n = 68)
Unadjusted	1.31	0.84, 2.04	2.95	1.93, 4.52
Adjusted for: age, race education, marital status	1.45	0.92, 2.30	2.89	1.85, 4.49
Branch of service, military rank	1.33	0.85, 2.09	2.95	1.91, 4.54
Parity, history of spontaneous abortion	1.30	0.83, 2.04	2.99	1.95, 4.58
All, history of spontaneous abortion	1.44	0.91, 2.29	2.92	1.87, 4.56
All, history of fetal loss	1.45	0.91, 2.30	2.90	1.86, 4.53
Ectopic pregnancy		(n = 10)		(n = 32)
Unadjusted	1.74	0.63, 4.82	8.46	3.49, 20.5
Adjusted for: age, race, education, marital status	1.92	0.68, 5.40	6.96	2.83, 17.1
Branch of service, military rank	1.73	0.62, 4.84	7.81	3.21, 19.0
Parity, history of ectopic pregnancy	1.75	0.63, 4.87	8.08	3.28, 19.9
All, history of ectopic pregnancy	1.91	0.67, 5.46	7.70	3.00, 19.8
All, history of fetal loss	1.90	0.67, 5.41	7.35	2.97, 18.2

*Compared to conceptions of nondeployed women from deployed units (referent group). All = age, race, education, marital status, branch of service, military enlisted rank, parity.

TABLE 4. Reproductive outcomes among Gulf War-exposed pregnancies: in-theater conceptions compared with predeployment conceptions, August 1990 to May 1992

	In-theater conception (n = 327)		Predeployment conception (n = 88)		p-value
	No.	%	No.	%	
Live birth	274	83.8	76	86.4	0.556
Still birth	1	0.3	0	0	0.603
Spontaneous abortion	38	11.6	10	11.4	0.947
Ectopic pregnancy	9	2.8	1	1.1	0.380
Induced abortion	5	1.5	1	1.1	0.784

997 GW-exposed pregnancies are estimated based on our self-administered questionnaire, similar to prior estimates (6).

The prevalence of clinically recognized spontaneous abortions in the general population ranges from 10% to 15% (20), which is consistent with our observations among GW-exposed and NDV conceptions, but was twice as high among GWV postwar conceptions. Ectopic pregnancies occur in 1% to 2% of conceptions (21), similar to that observed among GW-exposed and NDV conceptions, however, 11% of GWV postwar conceptions were ectopic pregnancies.

Conceptions that were gestating in the Gulf War environment had similar reproductive outcomes as those of non-deployed women. Fetuses gestating in the war environment would seemingly be at higher risk for adverse outcomes. Anecdotal reports, including those of our participants, suggest that occupational and behavioral hazards associated with fetal losses including carrying heavy loads, prolonged standing, cigarette use, and frequent caffeine consumption were common during the Gulf War (22–24). The similarities in reproductive outcomes of GW-exposed pregnancies that were conceived in-theater to those conceived prior to deployment were also unexpected. Exposures during the 3 months prior to conception are important determinants of birth outcomes. In-theater conceptions might be expected to have poorer reproductive outcomes if preconceptional exposures in the war environment were unfavorable, and the fathers of these unborn infants were presumably GWVs who shared similar environmental exposures.

We were unable to determine the etiology of the excess risk of spontaneous abortions and ectopic pregnancies among GWV postwar conceptions. However, the elevated prevalence of reported spontaneous abortions and ectopic pregnancies among GWV postwar conceptions are consistent with military hospitalization data. We analyzed pregnancy-related diagnostic data among servicewomen admitted in military hospitals between 1989 and 1993. Women classified as GWVs (by DMDC) had significantly higher hospitalization rates for spontaneous abortions in 1991 (GWVs = 9.8% vs. NDVs = 6.8%) and for ectopic

pregnancies in 1990 and 1991 compared with women classified as NDVs. Elevated prevalence of spontaneous abortions was also reported among postwar conceptions of male Gulf War veterans (1) and conceptions in Kuwait and Bahrain during the post-invasion period through 1995 (25, 26). The excess ectopic pregnancies might be associated with elevated hospitalization rates of genitourinary infections and inflammatory disease of the ovary and fallopian tube among GWV women after 1991 (27). Further, bacterial vaginosis has been associated with late miscarriage, and was the second most frequently diagnosed gynecological disorder among ambulatory visits during the Gulf War (8, 28). It is unclear if unfavorable preconceptional exposures and genitourinary infections during the war augmented the risk of spontaneous abortions and ectopic pregnancies among postwar conceptions.

Important methodologic limitations must be acknowledged. The etiology of fetal loss is multifactorial and complex. We did not have information on known risk factors for fetal loss, including smoking, alcohol, caffeine, medication, exposure to recognized abortifacients, pelvic inflammatory disease, infections, fallopian tube damage or other biological factors (29). Although the prevalence of *chlamydia* infection among female military recruits is high (30), we did not have such information for this cohort. Further, fetal tissue from spontaneous abortions was not available for cytogenetic analysis.

Selection bias might have occurred since the study population was limited to admissions in military hospitals for pregnancy-related diagnoses. Members of the reserves and National Guard (14.3% of GWVs) were not represented because they are generally ineligible for admission to military hospitals unless they are on active duty. Women whose pregnancies were diagnosed in the Gulf War were evacuated immediately from the war theater, and they likely sought care in military hospitals in their home commands. However, if they experienced a miscarriage in-theater, treatment was likely provided in an outpatient medical facility or a nonmilitary hospital near the Gulf region. Such women would not be included in our sample unless they were admitted in a military hospital for subsequent treatment or another pregnancy-related diagnosis during the study period.

We did not have access to records from military outpatient clinics or nonmilitary hospitals, and were unable to identify and enroll such women.

The comparison groups were limited to women who belonged to deployed military units and did not include women from nondeployed units. However, the use of nondeployed women (who belonged to deployed military units) enables comparison among groups that are homogeneous with regards to ethnicity, military occupation, reproductive history, and prewar exposures, thereby reducing the likelihood of confounding.

Cohort selection included births occurring <41 weeks after military units returned from deployment. Individual return dates preceded unit return dates for many women, such that postwar births actually included births up to 16 months after women returned from deployment, thereby reducing the likelihood of only capturing fetal losses or conceptions that occurred immediately after women returned. Further, mean gestational age and birthweight among live births did not differ among the 3 deployment categories, suggesting our selection criteria did not disproportionately capture pregnancy outcomes with shorter gestations (31).

Some conceptions might have been misclassified for women with predeployment conceptions. Thirty deployed women experienced a fetal loss prior to deployment, but these conceptions were not included in the analyses although they might have been classified as nondeployed conceptions if the women were not subsequently deployed. However, if we include these 30 prewar fetal losses to NDV conceptions, the excess of spontaneous abortions (OR: 1.7, 95% CI: 1.2–2.5, $p = 0.004$) and ectopic pregnancies (OR: 6.7, 95% CI: 3.1–14.9, $p < 0.001$) among GWV postwar conceptions persists.

Recall bias might have occurred since the questionnaire was administered 6 to 7 years after the Gulf War. Recollection of accurate individual dates of deployment and precise gestational weeks could have resulted in misclassification of Gulf War-exposed pregnancies, despite our conservative classification criteria. Spontaneous abortions were incompletely ascertained and were limited to clinically recognized pregnancies. Approximately 30% of biochemically ascertained conceptions are terminated spontaneously (32), however only 10% to 15% are clinically recognized (20).

The large representation of women in the Gulf War raises important health policy concerns. Although Gulf War exposed-pregnancies and nondeployed conceptions had similar reproductive outcomes, a war environment is not a desirable venue for fetal development. The majority of these Gulf War-exposed pregnancies could have been prevented. Consideration should be given to provide contraceptives to men and women during deployment, including condoms for prophylaxis against pregnancy and sexually transmitted diseases, and oral contraceptives for pregnancy prevention and

menarcheal-related problems (33). Adequate gynecologic services, including assessment of pregnancy and its complications should be considered for prospective deployments. Routine pregnancy testing should be offered to women prior to deployment, particularly prior to administration of prophylactic medications and vaccinations. Such preventive interventions will protect the health of women in the military and the children they carry.

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