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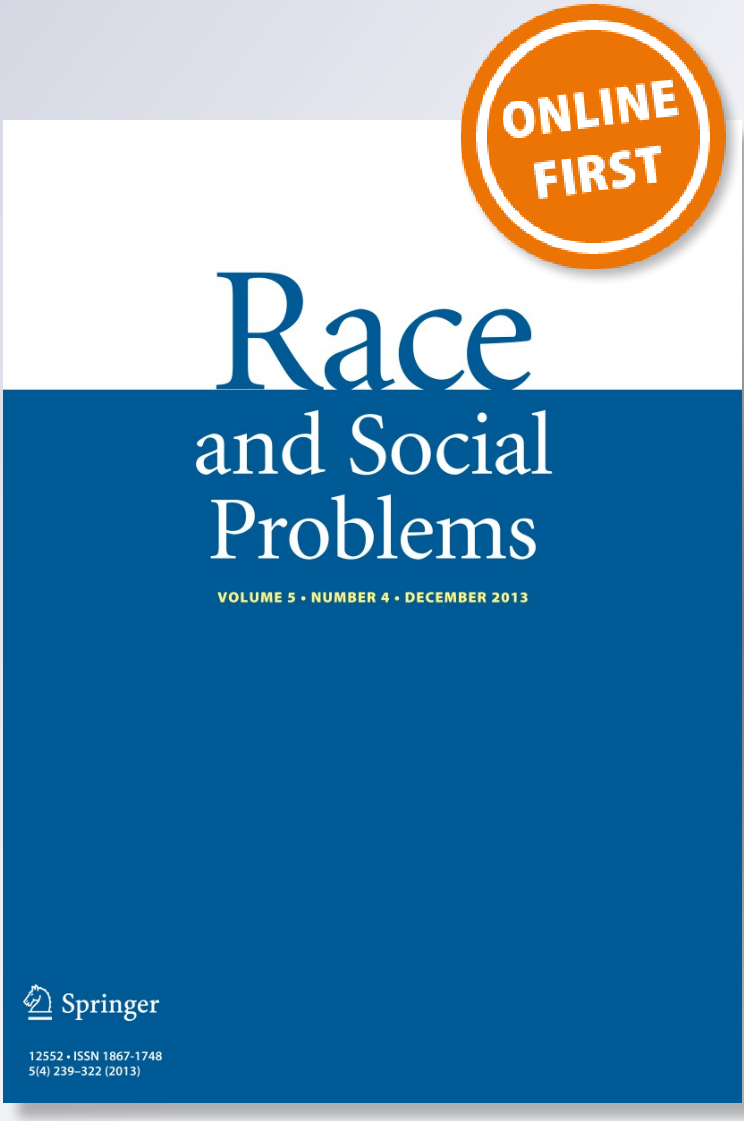

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Abstract Research has been unable to determine why African Americans have higher infant mortality and preterm birth prevalence than whites, even taking into account measurable social and economic differences. This is, in part, due to the difficulty of adequately measuring the impacts of racial inequality and residential segregation. As an alternative approach, this paper comparatively examines infant outcomes among military-affiliated and civilian black and white women. The military setting provides higher-than-average economic equality and universal healthcare access. Although military-affiliated populations are usually left out of most major datasets, we construct a new variable that allows us to identify military affiliation using the CDC's PRAMS survey data. Multinomial logistic regression analyses show that there is a negative association between adverse birth outcomes and military affiliation for both white and black women. Thus, the black-white infant mortality gap persists in the military even though black affiliates experience significant improvement in outcomes relative to their same-race civilian counterparts. Nevertheless, the black-white disparity among military-affiliated women is somewhat lessened compared to the black-white civilian disparity.

Keywords US racial disparities · Infant mortality · Preterm birth · Military

Introduction

Pervasive racial disparities in very basic quality of life indicators, such as life expectancy, health, and poverty, are sobering reminders of America's continuing nexus of black–white inequality. Infant mortality, one of the most universal measures of a society's well-being, is no exception. The primary cause of high infant mortality is severe preterm birth (<32 weeks), with black infants almost twice as likely as white infants to be born preterm and three times more likely to die from preterm-related complications (MacDorman and Mathews 2011). These higher rates not only reflect pre-existing racial inequality, but they also reproduce it. Children who survive preterm birth are at a higher risk of long-term health and developmental challenges and costs, contributing to continued racial health disparities among children and adults (Behrman 2007; Moster et al. 2008). For these reasons, prematurity is a major public health concern, and closing this race gap was identified a decade ago by the US government as a primary health objective to be achieved by 2010 (U.S. Department of Health and Human Services 2010). However, there has been little progress, and substantial debate remains over the source of racial differences in birth outcomes.

Of hundreds of studies, none have been able to explain why African American infants have more adverse birth outcomes, even when exhaustive social and economic indicators are taken into account. Because racial

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inequalities are so pervasive and reinforced by racial residential segregation, simply controlling for socioeconomic characteristics fails to fully account for the overriding influence of racial inequality on most health outcomes, including infant mortality and preterm birth, of African Americans relative to whites. Locating a black subpopulation that experiences higher-than-average economic equality and health care access provides an alternative opportunity to examine birth outcomes among blacks and whites in the United States. In this article, we identify a control group, black women affiliated with the US military in active service or as dependents, to re-examine the role of racial inequality in the risk of preterm birth. We look at the military system as a social environment that differs in several fundamental ways from civilian society. The three factors commonly forwarded to explain the worse health outcomes of African Americans are: (a) socioeconomic inequality, (b) unequal access to health care, and (c) pervasive residential racial segregation, which compounds and intensifies the effects of (a) and (b). We argue that the first of these three factors is notably mitigated in the military setting, while the remaining two factors are absent.

We investigate whether the risk of infant mortality and preterm birth among non-Hispanic black and white military and civilian women differ in an effort to understand whether differential social environments mitigate the racial disparity in reproductive risks.

Socioeconomic Inequality and Unequal Access to Health Care

A family's socioeconomic status (SES) is directly correlated with almost all health outcomes, including reproductive outcomes. It is not surprising, then, that generalized SES measures, such as low income, low educational attainment, and poverty, are influential predictors of prematurity and infant mortality (Berg et al. 2001; Cramer 1995). Racial differences in socioeconomic status are well documented. Black families have, on average, substantially lower median incomes than whites and they are half as likely to have graduated from college (Crissey 2009; DeNavas-Walt et al. 2010). They are twice as likely to be unemployed, less likely to own a home, and their median wealth is twenty times less than whites' (Taylor et al. 2011; United States Census Bureau 2010).

The pathways through which SES impacts health are multifaceted. Purchasing power is a direct pathway, such as the ability to buy health care or to buy quality housing with minimal toxin exposures in safe neighborhoods. Other SES pathways may be more indirect, such as the influence of education on healthier, preventative lifestyles and lesser mental stress throughout the life course. Due to data limitations and the difficulty of measuring these pathways, basic SES measures are often used as a proxy for all of these conditions.

An important SES linkage to health is the ability to purchase health care. Access to adequate medical coverage is associated with healthier, full-term births. While 12 % of white Americans lack health care coverage, 21 % of black Americans do (DeNavas-Walt et al. 2010). Even among the insured, the average African American woman receives lower quality health care than the average white woman. While white women are more likely to have private insurance or access to family coverage through their spouse, black women more often have public sources of medical insurance, which is associated with more overcrowded and underfunded care (Institute of Medicine 2003; National Institutes of Health 1998). Thus, minority women are more likely than white women to delay prenatal care until the third trimester or to forego it altogether (Cramer 1995). A lack of prenatal care is associated with 2.8 increased odds of preterm birth (Vintzileos et al. 2002).

While access to prenatal care is an important determinant of infant health outcomes (Liu 1998; Vintzileos et al. 2002), even more important may be the mother's health before she becomes pregnant. The combination of lower socioeconomic status, poor health care, and related stress throughout the life course means that black women have an unusually high degree of health challenges at almost every age compared with white women. This has been called the "weathering hypothesis," where repeat exposure to adverse conditions over the lifetime leads to advanced health deterioration as African Americans age (Geronimus 2001). Overall, African Americans are far more likely to have diabetes and hypertension than whites at all ages (Frieden 2011), both of which increase the risk of preterm birth (Goldenberg and Rouse 1998).

Lower socioeconomic status is associated with a cluster of behaviors that elevates the probability of premature birth. Lower income and education predict increased risk behaviors, such as smoking and alcohol consumption, which lead to adverse birth outcomes (Chomitz et al. 1995; Guendelman and Abrams 1995). An individual's SES is also linked with reduced health-seeking lifestyles, such as poor nutrition and sedentary lifestyles, and younger, nonmarital fertility that is associated with reduced social supports and fewer resources (Cramer 1995; Sastry and Hussey 2003). As a reflection of black–white differences in SES, African Americans have notably higher obesity rates than whites, as well as higher non-marital fertility rates (but notably have lower rates of tobacco usage and alcohol consumption), all of which are associated with poor birth outcomes (Ventura 2009).

Economic marginalization is likely accompanied by intensified mental stress related to financial hardship and fewer familial and institutional social supports. Some research has begun exploring how such SES-related stress exposures may have physiological consequences. Indeed, maternal exposure to chronic stress, which is elevated among those with lower SES, has been linked to increased risk of infection, instability of the autonomic nervous system, hypertension, and preterm birth (Culhane et al. 2002; Lu and Lu 2004).

Thus, racial disparities in birth outcomes would appear to be largely a story about compositional differences between black and white Americans in the ways that unequal socioeconomic status manifests itself via myriad health pathways. As such, studies that control for SES, health care access, and SES-related health factors should be able to explain the black–white disparity in such outcomes. However, when adjustments are made for prenatal care and SES-related differences across racial groups for the wide range of maternal characteristics delineated above, the racial disparity in infant outcomes is only partially explained (Berg et al. 2001; Hummer 1993; Hummer et al. 1999; Sastry and Hussey 2003; Schoendorf et al. 1992). The inability to fully explain racial disparities in birth outcomes has led some researchers to point to possible genetic differences (Varner and Esplin 2005; Van den Oord and Rowe 2000, 2001; Wilcox and Russell 1986). For example, a specific maternal gene said to be responsible for lowering birth weight, polymorphism in the G protein-3 subunit C825T (Hocher et al. 2000), occurs in Africans and African Americans more frequently than it does in whites (Siffert et al. 1999). Genetic-based approaches are questionable to the extent that they perpetuate an essentialist concept of race despite evidence that there is more genetic variation among individuals of any given racial group than there is across racial groups. While genetic proclivities may interact with social determinants to result in biologic manifestations, genetic approaches alone cannot explain the complex preterm birth trends among African Americans, nor can they offer constructive prevention strategies. US research comparing birth weights among African-born immigrant women, US-born white women and US-born black women finds no weight difference between African and white births, with lowest birth weights for black American-born women, suggesting the more important role of environment over genes (David and Collins 2007).

We reconsider conventional social explanations, such as health care and SES, placed in their larger, racialized context. In a society where racial residential segregation is the norm, even if an individual has higher SES and access to privatized prenatal care, those advantages may be undermined by concentrated disadvantage at the neighborhood and community level. Williams and Sternthal (2010) make this argument forcefully in a piece showcasing the litany of ways that black–white comparisons using conventional categories of SES and health care are problematic because higher SES fails to buy black households out of segregated communities. Thus, it is unlikely that generic survey measures of SES and health care adequately capture the full range of inequality experienced by African Americans that, in turn, contribute to infant mortality and premature birth.

The impact of segregation on birth outcomes is a relatively new area of research. One study has found that the risk of severe preterm birth (<32 weeks) for black women is linked to neighborhood poverty and housing vacancy (Reagan and Salsberry 2005). A major challenge is that segregation levels are so ubiquitous that finding variation in neighborhood racial composition is virtually impossible. Promisingly, a national study oversampling some of the few racially integrated communities in the United States has shown significant racial disparity reductions in other health outcomes, such as diabetes and hypertension (LaVeist et al. 2009; Thorpe et al. 2008).

The Military: An Alternative Setting

As we have seen, marginalized socioeconomic and residential conditions faced by African Americans in US society remain common enough that locating compositionally similar populations of blacks and whites is difficult. Racial segregation exacerbates this problem regardless of whether one is more economically advantaged on an individual level. For this reason, the military community may be a useful contrast to civilian society. Important race differences in health factors and socioeconomic status that may shape reproductive outcomes are mitigated among military affiliates (even beyond selectivity of military enlistment). But crucially, residential racial segregation is absent in the military setting, which we theorize should lead to improved reproductive outcomes among African Americans military affiliates.

Full health care coverage and, by extension, prepregnancy and prenatal care for service personnel and their families is part of the constellation of benefits provided to all active duty members. This is an important departure from civilian life. Access to the same quality of health care is available for all military members, spouses, and dependents, regardless of their rank or income level. It is estimated that 30–45 % of junior-enlisted members would have no access to public or employer-provided health care coverage had they been working in the civilian sector (Department of Defense 2008). In addition to being universal, the quality of military health care has been found by civilian review boards to be high (Office of Management and Budget 2007; Rawlings and Weir 1992). Studies have shown that in countries where health care is universally available, mothers initiate prenatal care earlier than in the United States and have better overall infant health outcomes (Buekens et al. 1993). Might women affiliated with the military benefit in the same way?

In addition to offering universal health care, the military setting is distinct from larger society in that socioeconomic inequality is substantially reduced due to top-down enforcement of equal opportunity policies and the presence of a disproportionately large African American population (Lundquist 2004, 2008; Mare and Winship 1984; Moskos and Butler 1996; Sampson and Laub 1996). Poverty in its most extreme form is eliminated in the military by the fact that it is an environment where at least one parent is employed. Furthermore, there is no pay difference between individuals of the same rank, whereas the variation in income across two civilians of similar age and education varies significantly. Similarly, promotion is standardized, well-defined, and primarily based on time in rank. In this respect, the institution has been referred to as a "socialist meritocracy" (Webb 1997, p. 20).

The military compensation package has a monetary value that doubles the cash value of the income and allowances received by soldiers and their families, making their total compensation equivalent to the top 80th percentile of same-age civilians (Department of Defense 2008). This is not to say that there is no economic hardship in the military. Some junior-enlisted families, particularly single parents in the military, qualify for various forms of welfare assistance (Wahl and Rundall 1996). Still, given that most soldiers enter the military with only a high school degree or GED (80 %), the economic stability and benefits available to their families are much higher than what they would have access to in the civilian service economy.

This contrast is especially pronounced for black soldiers and their families who more often come from disadvantage. Substantially more black soldiers than white soldiers grow up below the poverty line (Seeborg 1994). One study of enlistment intentions found that black soldiers were the most likely to say they planned on re-enlisting (Moore 2002), and another found that, of all groups in the military, black men and their spouses most commonly said that financial compensation and promotional opportunities were better than in civilian society (Lundquist 2008). Extensive analyses of veterans and their families from disadvantaged backgrounds find that military service confers a life course advantage in both educational attainment and employment (MacLean and Elder 2007). It is not surprising, then, that some racial disparities and outcomes common among the civilian population do not apply to those in the military (Lundquist 2004, 2006; Lundquist and Smith 2005).

Finally, the major counterfactual condition of the military is its well-known racial integration of living and working spheres. In this way, military service reduces both individual-level and community-level racial inequality for families. The explicit racial integration of military bases means that many minority family members who would otherwise be living in disadvantaged neighborhoods and school systems are removed from such conditions (Crockett 2000). Research has identified a trickle-down integration effect on regions outside military bases, which stems historically from Department of Defense directives in the early 1960s (Hershfield 1985). Thus, even families who choose to live outside military bases in the local economy are living in metropolitan areas that have the lowest levels of African American residential segregation in the United States (Farley and Frey 1994). The index of dissimilarity for blacks living in Jacksonville, North Carolina (just outside of Camp Lejeune), for example, is 27.9, the lowest level of any city in the United States, compared to, for example, Asheville, with a dissimilarity level of 66.2, or New York City, with a dissimilarity level of 85.3 (CensusScope 2011).

Although the military setting may offset many inequalities of civilian life, it has its own set of institution-specific stressors. Military personnel and their families face high levels of stress during wartime due both to the anticipation of deployment to the war zone and the conditions of deployment itself (from 2001 to the present, the military has been involved in extensive military engagements abroad). The possibility that we do not adequately capture stress induced by wars would underestimate the otherwise mitigating effect of military service on infant outcomes, although in separate analyses we found the interaction between military affiliation and the variable demarcating a war period to be insignificant. And even in peacetime, military families are subject to stressful family separation due to training exercises and frequent relocations. It should be noted that, at the same time, the military, cognizant of the fact that most individuals in the military have families and that family well-being directly affects manpower retention, implements a variety of social support structures aimed at spouses and children in anticipation of such challenges (Burland and Lundquist 2012).

There are only three studies, all published in medical journals, that have examined birth outcomes in the military. Due to the difficulty in obtaining military data, these studies either lack a civilian comparison or are limited to one state. None have access to expanded controls for health care, socioeconomic status, and maternal health-seeking and risk-taking behaviors. Of the three, two utilized linked birth and death records that identified births from military hospitals in Washington state and California, and found that racial disparities in low birth weight and infant mortality among births born in military hospitals were lower (Barfield et al. 1996; Rawlings and Weir 1992). The other study used retrospective birth histories of enlisted women and found that the prevalence of black–white difference in low birth weight was lower among women in the military compared to national civilian statistics (Adams et al. 1993). These studies are a promising indication that contextual settings can alter stubborn health disparities; however, because they had very limited SES controls it is unclear how much of their results are driven by positive selectivity of individuals who are affiliated with the military. And without direct civilian comparisons in their datasets, it is difficult to generalize to those larger societal disparity trends that we reviewed earlier in the paper.

Our analysis provides a *direct* military comparison to civilians in a nationally representative reproductive health survey that contains a rich set of contextual SES and health-related variables measured before and during pregnancy. We are also able to extend our analysis to multiple states and all military branches and cover an expanded time period.

We argue that factors that influence reproductive outcomes, health, and SES variables are likely to be more favorable in the military than in civilian life, especially for black women. We lack measures of community-level racial integration in our data, but we theorize that the lack of segregated conditions will mainly work through the SES and health variables, allowing them to have a stronger impact among black women in the military setting than in civilian life. We thus hypothesize that racial disparities in infant mortality and preterm birth will be reduced in the military setting and may even be absent. Relatedly, we expect that black military affiliates in particular will be advantaged in these birth outcomes relative to their civilian peers. We expect that such a military-civilian advantage should disappear after controlling for demographic, SES, and health variables.

Method

Analytical Approach

The key independent variables in our analyses are: (a) whether the mother is white or black and (b) whether the birth was civilian or military-affiliated. We code these two characteristics as follows: black military, black civilian, white military, white civilian. We conduct two analyses comparing the effects of each of these statuses, one predicting infant mortality and one predicting preterm birth. In the first instance, pregnancy risk assessment monitoring system (PRAMS) solicits data on infant death from the death certificate, as well as from the mothers. The surveys are conducted between two and four months after birth, so our measure of infant mortality is not a full year's risk of mortality, as is conventional, and will be underestimated. To account for differing lengths of mortality risk periods within which women receive the survey, we control for the age of the infant (and age-squared) at survey period. Infant mortality is a rare occurrence, but by combining three phases together we gathered large enough samples to conduct the analysis (although still quite small for our subgroups of interest). Not all phases collect the date of death, however, and so while a duration-based survival analysis would be preferable, we must rely on logistic regressions to predict the likelihood of infant death for black and white civilian and military affiliates.

We also estimate multinomial logistic regressions to examine the likelihood and severity of preterm birth among the subgroups. Here, our sample sizes are much larger. Although preterm birth is highly correlated with infant mortality, it is important to study in its own right because of the long-term health conditions it can cause in preterm infants who do survive. We model a three-category outcome variable that distinguishes between severity of preterm birth and full-term birth. We use gestational age based on the mother's last menses and define a *severe preterm birth* as a birth delivered at less than 32 weeks of completed gestation; a *moderate preterm birth* as taking place between 32 and 36 weeks; and a *full-term birth* as one of 37+ weeks. We make this distinction because, although the former are more common, the negative health consequences of the latter are more substantial than those of moderate preterm births, accounting for a large proportion of infant deaths (Martin et al. 2008).

Sample

We use unique retrospective cohort data from the PRAMS, an ongoing state-based surveillance system funded by the Centers for Disease Control and Prevention (Department of Health and Human Services 2008). In most datasets, military affiliates are either excluded or impossible to identify. We applied for special permission from each participating state in PRAMS to flag births in military hospitals over a 10-year period, from 1995 through 2005. Using this, combined with military insurance information (TRICARE and Champus), we created a dataset containing large enough samples of non-Hispanic military-affiliated women for comparison to civilians: $N = 1{,}295$ black affiliates; $N = 3{,}788$ white affiliates; $N = 59{,}527$ black civilians; and $N = 169{,}072$ white civilians. Race was determined from the mother's self-identification on the birth certificate.

Pregnancy risk assessment monitoring system is designed to monitor selected self-reported maternal behaviors and experiences among women who recently delivered a live-born infant. Using standardized data collection methods, monthly stratified samples are selected from recent birth certificates. Surveys are obtained from mothers using a mixed-mode data collection method with mailed questionnaires and telephone follow-up for nonrespondents. Survey data are linked to birth certificate data and weighted for sample design, non-response, and non-coverage. Response rate is 70 % or higher from each state. Response rates in PRAMS tend to be lower for unmarried and lower educated women. Since these characteristics are positively correlated with race and negatively correlated with military affiliation, non-response could affect our sample. We adjust for this possibility using the PRAMS non-response sampling weights. We conduct our analyses using Stata svyset to account for selection and response probabilities of the survey design. We include an "Appendix" section to detail the construction and format of the PRAMS variables used in this analysis.

Some caveats are in order. Although these data, with military sampling and rich array of individual- and household-level variables collected prior to conception and during pregnancy, is better than what currently exists, it has drawbacks. First, we cannot distinguish between active duty soldiers and family of soldiers. But military demographics indicate that most women in the military community are spouses. The female soldier to spouse ratio is 1–3.8 (Office of the Deputy under Secretary of Defense 2005). Like soldiers, spouses experience the economic and community benefits of military affiliation, but they are, by definition, married, which skews their sample relative to civilians (it bears mentioning that female soldiers, black and white, are also disproportionately married; see Lundquist 2004; Lundquist and Smith 2005). Second, and relatedly, there is bound to be selection when it comes to individuals who are recruited (and self-select) into the military. The sample's weight toward spouses helps mitigate this problem insofar as they are not subject to military admission criteria, although they are likely to share some characteristics based on marital homophily norms. While we control for many important maternal health and SES attributes that may differentiate military affiliates from civilians, unobserved heterogeneity is still a likely possibility.

The PRAMS data contain a wide range of maternal characteristics that have been found to influence birth outcomes. We hypothesize that black military women are more advantaged than black civilian women and that the racial gap in SES and health-related factors will be significantly diminished in the military. We control for these characteristics in the multivariate analysis to examine the extent to which they help explain differences in the risk of preterm birth among black military, black civilian, white military, and white civilian women. Our variables include basic demographic controls (maternal age, birth year, parity, birth interval, baby's gender, and region), controls for SES (educational attainment, marital status, government assistance, and financial hardship), and health-related factors (usage and quality of prenatal care, prevalence of hypertension, pre- and postpregnancy weight gain, drinking and smoking, and stressful events). The construction of these variables is described in detail in "Appendix" section. In Table 1, we describe their distribution across our sample subgroups.

Results

Descriptive Results

Table 1 shows the sample subpopulations and variables we use for our controls in the regressions. We subdivide the data into four columns. Leftmost are black women affiliated with the military and their civilian counterparts. Rightmost are white women affiliated with the military and white civilians. The final column indicates whether differences are significant across these four subgroups.

Overall, Table 1 indicates that black–white gaps persist in many characteristics associated with poor birth outcomes among military affiliates; however, the gaps are notably reduced compared to the civilian race gap, and in some cases absent. Both military affiliates have higher SES and better health than their same-race civilian counterparts, but the differences are often more pronounced among black women.

Compared to civilians, military women's births are more concentrated in the optimal birth age range of 20–29, likely due to the age distribution of women affiliated with the military. Civilian black women tend to skew younger than their military counterparts, where the reverse is true of white women. Military affiliates are more likely to be on their first births than civilian women. For those who have given birth before, previous preterm birth and spacing of less than two years between births are associated with subsequent prematurity. Black military affiliates in both measures have lower prevalence than black civilians, but there is still a notable race gap in both subgroups.

The black–white gap in educational attainment is dramatically lessened in the military. At the highest educational level, this reduction is due to the fact that fewer white military women have a college degree than white civilian women. Among black mothers, military affiliates are more likely to have graduated from high school and to have an associate's degree than black civilian women. Some of these differences are probably due to military screening guidelines and related marital educational homophily for military spouses; however, the military also offers free subsidized online and on-site continuing education and higher degree granting programs to soldiers and family members.

Additional measures of SES indicate smaller black–white differences among military than civilian women. Government assistance (welfare and Medicaid receipt) is the indicator of lower income level, and black mothers in

Table 1 Descriptive data: PRAMS data by race and military status

	Black		White		Sig. diff.
	Military	Civilian	Military	Civilian	
N	*N* = 1,295	*N* = 59,257	*N* = 3,788	*N* = 169,072	
Maternal and pregnancy demographics					
Mother's age					
<20	11.7 %	21.2 %	9.7 %	8.9 %	bc
20–29 (omitted)	66.9 %	54.9 %	63.3 %	50.8 %	bcd
30–34	13.4 %	14.9 %	19.7 %	25.9 %	abd
35+	8.0 %	9.0 %	7.3 %	14.5 %	bd
First birth	44.4 %	39.5 %	47.8 %	42.6 %	bcd
Year of birth	2000.6	2001.1	2000.8	2001.1	cd
Short birth interval	10.8 %	12.0 %	9.1 %	7.8 %	abc
Male birth	51.0 %	50.6 %	51.0 %	51.1 %	
Region					
Southeast (omitted)	61.2 %	51.2 %	37.8 %	33.4 %	abcd
Northeast	7.0 %	13.0 %	7.4 %	17.4 %	bcd
Midwest	3.5 %	23.9 %	4.3 %	27.3 %	bcd
Southwest	0.7 %	2.2 %	1.8 %	4.7 %	bcd
West	25.5 %	2.1 %	47.0 %	14.3 %	abcd
Infant age in weeks at interview	17.5	18.4	15.7	16.0	abcd
Socioeconomic factors					
Education					
College degree	11.8 %	11.3 %	24.1 %	32.4 %	abd
Associates degree	36.6 %	23.3 %	32.1 %	23.9 %	abcd
High school graduate (omitted)	43.6 %	39.7 %	37.8 %	31.2 %	abcd
No high school degree	8.0 %	25.7 %	6.2 %	12.5 %	abcd
Financial hardship	27.0 %	43.8 %	23.1 %	32.2 %	abcd
Married	70.9 %	28.9 %	92.3 %	76.4 %	abcd
Government assistance	17.8 %	69.1 %	6.5 %	31.3 %	abcd
Health-related factors					
Prenatal care utilization					
Inadequate	16.2 %	18.7 %	8.2 %	7.4 %	ab
Adequate (omitted)	42.5 %	39.2 %	45.8 %	49.1 %	abcd
High	13.8 %	11.9 %	17.3 %	12.1 %	ad
Overexpected	27.5 %	30.2 %	28.7 %	31.4 %	bd
Prenatal care quality					abcd
Scheduling inflexibility	23.3 %	27.0 %	23.8 %	16.5 %	bcd
Consultation thoroughness	9.2	8.0	8.3	7.9	acd
Smoked during pregnancy	3.7 %	8.4 %	10.4 %	17.1 %	abc
Mother's prepregnancy weight					
Underweight	9.5 %	10.9 %	14.6 %	15.2 %	cd
Normal weight (omitted)	55.6 %	45.6 %	55.0 %	54.2 %	bc
Overweight	13.9 %	13.8 %	13.3 %	10.8 %	bd
Obese	18.7 %	26.4 %	16.0 %	18.0 %	bcd
Adequate pregnancy weight gain	42.7 %	46.4 %	43.1 %	47.3 %	d
Hypertensive during pregnancy	5.8 %	5.8 %	6.7 %	5.2 %	bd
Previous low weight birth	6.3 %	10.2 %	3.1 %	4.1 %	abcd
Stressful events					
Emotional incidents	33.3 %	38.0 %	34.5 %	34.5 %	bc

Table 1 continued

	Black		White		Sig. diff.
	Military	Civilian	Military	Civilian	
Partner-related incidents	47.3 %	52.0 %	31.6 %	30.6 %	abc
Traumatic incidents	21.7 %	28.2 %	13.2 %	17.5 %	abcd
Relocated	52.0 %	35.4 %	57.6 %	36.3 %	abcd
Abuse incidents	6.5 %	8.9 %	2.7 %	4.5 %	

Percentages are weighted; *N* is unweighted

a Where significant difference ≤0.05 between black military and white military

b Where significant difference ≤0.05 between black civilian and white civilian

c Where significant difference ≤0.05 between black civilian and black military

d Where significant difference ≤0.05 between white civilian and white military

both subgroups are more likely to receive such assistance. While it might be surprising that military affiliates receive any federal assistance, some junior-level, family income levels are low enough to qualify them for assistance, primarily in the form of WIC receipt. Lower income military families also qualify for supplemental Medicaid insurance for children with disabilities. Marital childbearing, a proxy for parental time and resources, is notably more common among military affiliates than civilians, and the difference is especially pronounced for black mothers. Studies show that marriage is extremely high in the military (Lundquist 2004; Hogan and Seifert 2010; Teachman 2009); however, these proportions here are probably as high as they are because so many women are military spouses. We also include a measure of financial hardship, which asks whether the mother or partner had problems with bills or was unemployed in the 12 months leading up to the birth. Financial hardship is significantly lower in the military setting, again with the biggest difference among black mothers.

Access to, quality of, and timing of prenatal care are important predictors of infant health outcomes. In Table 1, we show a measure of prenatal care visits and timing with an Adequacy of Prenatal Care Utilization index, explained in detail in "Appendix" section. The adequate category indicates the optimal prenatal care for most healthy pregnancies. Black women, regardless of military affiliation, are more likely to fall into the inadequate care category, meaning they are less likely to initiate care early in the pregnancy and as frequently. It is notable that even in a setting where health care is universal and free, black military women's prenatal care is nevertheless underutilized relative to white military women, with twice as many black military women falling into the inadequate category.

We use two measures to gauge access to and quality of prenatal care. The scheduling inflexibility variable indicates that the mother was unable to get an appointment when she wanted one. We measure quality of care by a count of the number of educational topics that were covered by the health practitioner during prenatal visits. The black–white gap in scheduling difficulty disappears in the military mainly because white military affiliates report more difficulty compared to white civilian women. Because prenatal care is universally available for military families, getting care may be in higher demand. Both black and white women report a greater number of educational topics discussed in the military prenatal care setting.

Table 1 shows that black women and especially military affiliates are less likely to smoke during pregnancy than white women. There is no significant black–white difference in normal weight, overweight, or obesity prior to pregnancy among military affiliates as there is among civilians. Finally, the experience of stressful events is linked to hormonal change and physiological distress, which may lead to adverse birth outcomes. Therefore, we also include controls for women's reports of potential mental health stressors in the 12 months leading up to pregnancy, described in "Appendix" section. At the bottom of Table 1, black–white differences in these incidents are notably reduced in the military. The black–white gap is absent in the military in the case of emotional distress, and it is reduced for traumatic- and partner-related distress.

Finally, we include residential relocation because we know that this is an event that impacts military families more frequently than civilian families (Blinded) and is likely to cause stress due to logistical pressures and a loss in social networks. Table 1 shows that frequent relocations characterize the military population in equal measure by race. Residential relocation is the only stressful events measure where military affiliates report higher levels of distress than civilian women.

In sum, the descriptive results in Table 1 suggest that, compared to their same-race civilians, military blacks are more advantaged than military whites. Stated another way,

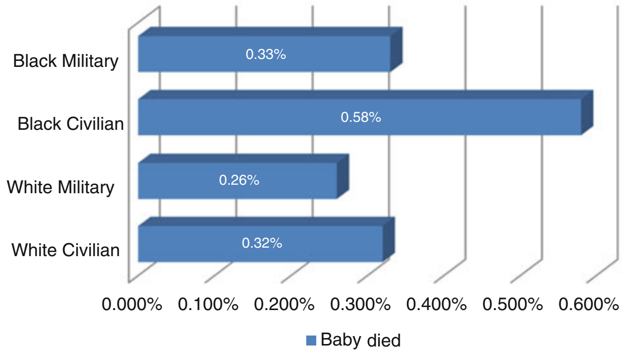

Fig. 1 Infant death by race and military status, PRAMS. Note that infant deaths in all cases are less than 1 % and thus we have enlarged the scale so that the differences across the subgroups can be better observed

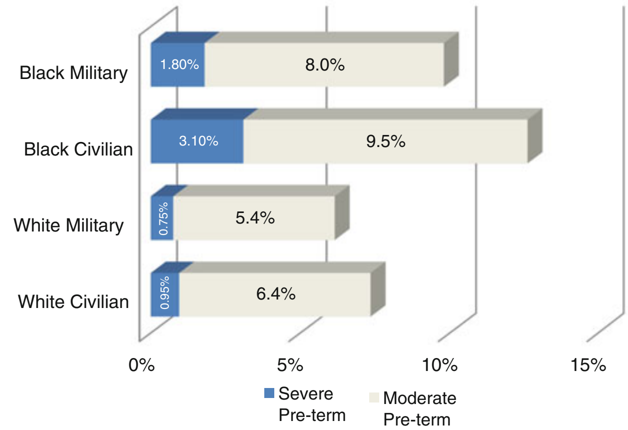

Fig. 2 Preterm birth severity by race and military status, PRAMS. All differences between the four groups in types of preterm births are statistically significant (at $p < 0.05$) except for early preterm births among white military and white civilian women

the civilian population of blacks is much more disadvantaged than the white civilian population. Improvements in the military setting certainly stem from positive selectivity of families who affiliate with the military, but some measures may also be attributed to conditions of the military environment itself. It is notable, however, that when considering the white and black subpopulations directly, comparisons show that whites are still more advantaged than blacks, even in the military.

Bivariate Results

We examine each of our dependent variables in the following figures. Figure 1 shows the infant mortality outcome distribution across the groups. The differences across the four groups are statistically significant (at $p < 0.05$), except for between black military affiliates and white civilians. Black civilians have the highest proportion of deaths while white military affiliates have the lowest. The military appears to be associated with a reduced prevalence of infant mortality for both black and white women, but the racial gap is much smaller among military affiliates.

Figure 2 shows the distribution of preterm births across our subgroups. It shows a similar pattern as the previous figure with lessened preterm birth in the military setting for all women, but with black military affiliates having higher preterm birth proportions than either group of white women, although still lower than for black civilians. Figures 1 and 2 indicate that a black–white gap persists among military women as it does among civilian women; however, it is reduced in the military setting despite the fact that white military women have lower infant death and preterm outcomes than the average white civilian. The military affiliation racial disparity is especially lessened for severe preterm births.

To what extent are the compositional differences shown in Table 1 responsible for the trends we find in the figures? We take these differences into account in our multivariate analyses that follow.

Multivariate Analyses

Table 2 presents results for our first outcome of interest: the likelihood of infant death. We show the military-race affiliation coefficients and how they are affected upon the inclusion of each grouping of control variables across nested Models 1–5. The fourth model is the full model. We also run a fifth nested model that is intentionally overcontrolled with the inclusion of preterm status. This shows us how highly correlated preterm birth is with mortality, providing a segue into our preterm birth models in Table 3. The comparison group for the military-race affiliation variables is black military women.[1]

Table 2 indicates that, prior to controls, the likelihood of death is greatest for black civilian infants and lowest for white military-affiliated infants. While there is the expected black–white disparity among civilians, there is also a large black–white disparity among military women. Contrary to our prediction, this general effect persists across all of the nested models until we introduce controls for preterm birth. For example, exponentiating the −1.45 coefficient for white military affiliates in Model 1 of the top panel of Table 2 and

[1] Although the convention is to omit the largest reference group, in this case White civilian women, we instead omit Black military women in order to show explicit comparisons across our main groups of interest. (We also reran models with each of other subgroups as omitted categories in separate analyses to verify significant differences).

Table 2 Logistic regression predicting infant mortality

Independent variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coff.	SE	Coff.	SE	Coff.	SE	Coff.	SE	Coff.	SE
Black civilian	0.58***	0.13	0.52**	0.13	0.37*	0.12	0.23+	0.12	0.08	0.31
White civilian	−0.23	0.30	−0.25	0.31	−0.22	0.22	−0.36	0.22	0.08	0.30
White military affiliate	−1.45***	0.30	−1.39***	0.08	−1.28***	0.10	−1.41***	0.31	−0.81*	0.11
(Comparison: black military)										
Maternal and pregnancy demographics										
Mother's age										
<20			0.21+	0.12	−0.09	0.14	−0.05	0.15	0.02	0.16
20–29 (omitted)										
30–34			−0.15	0.10	0.09	0.10	0.07	0.10	−0.09	0.11
35+			−0.02	0.13	0.21+	0.13	0.17	0.13	−0.11	0.14
Birth parity										
1st birth			0.13	0.09	0.20*	0.10	0.35***	0.11	−0.11	0.28
Year of birth			0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01
Short birth interval			0.55***	0.13	0.56***	0.14	0.56***	0.14	0.26+	0.13
Male birth			0.25***	0.07	0.25***	0.07	0.26***	0.08	0.18*	0.08
Region										
Southeast (omitted)										
Northeast			−0.005	0.10	0.02	0.10	0.11	0.11	0.10	0.12
Midwest			−0.04	0.11	−0.02	0.11	0.04	0.11	0.04	0.12
Southwest			0.52***	0.13	0.50***	0.13	0.53***	0.13	0.59***	0.15
West			−0.24+	0.14	−0.05	0.14	−0.05	0.14	−0.08	0.14
Weeks since birth			0.03	0.03	0.03	0.02	0.00	0.00	0.02	0.03
Weeks since birth-squared			−0.001+	0.00	−0.00	0.00	0.00+	0.00	0.00	0.00
Socioeconomic factors										
Education										
College degree					−0.72***	0.11	−0.66***	0.12	−0.48***	0.12
Associates degree					−0.41***	0.10	−0.42***	0.10	−0.31***	0.11
High school graduate (omitted)										
No high school degree					0.10	0.12	0.07	0.13	0.01	0.14
Financial hardship					0.14+	0.08	0.07	0.08	0.03	0.09
Married					−0.32**	0.11	−0.33**	0.13	−0.21+	0.14
Government assistance					0.02	0.09	0.03	0.08	−0.11	0.10
Health-related factors										
Prenatal care utilization										
Inadequate							0.37***	0.13	−0.08	0.13
Adequate (omitted)										
High							−0.24+	0.16	−0.19	0.17
Overexpected							0.77***	0.09	−0.19+	0.11
Prenatal care quality										
Scheduling inflexibility							0.20*	0.09	0.10	0.09
Consultation thoroughness							−0.09***	0.20	−0.06***	0.22
Smoked during pregnancy							0.19+	0.11	0.10	0.12
Mother's prepregnancy weight										
Underweight							−0.01	0.11	−0.17	0.12
Normal weight (omitted)										
Overweight							0.02	0.11	0.08	0.11
Obese							0.63***	0.11	0.45***	0.11

Table 2 continued

Independent variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coff.	SE	Coff.	SE	Coff.	SE	Coff.	SE	Coff.	SE
Adequate pregnancy weight gain							−0.74***	0.10	−0.38***	0.10
Hypertensive during pregnancy							−0.42***	0.13	−0.96***	0.13
Had a previous low weight birth							0.56***	0.11	−0.21^{+}	0.12
Stressful events										
Emotional incidents							0.04	0.08	0.09	0.08
Partner-related incidents							0.02	0.10	0.04	0.11
Traumatic incidents							−0.02	0.10	0.05	0.11
Relocated							−0.09	0.09	−0.01	0.09
Abuse incidents							0.08	0.13	0.07	0.15
Very preterm (<32 weeks)									4.96***	0.12
Moderate preterm (32–36 weeks)									1.77***	0.16

$^{+}$ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

subtracting it from one, we see that white military infants have a 77 % lower odds of death than black military affiliates. But white military affiliates also have an equally reduced likelihood of infant mortality compared to their own white civilian counterparts (to be precise, a 70 % lower odds, as seen in separate analyses). The clusters of controls introduced across Models 1–4 only slightly reduce the magnitude of the white military affiliate advantage.

Black civilian infants are 79 % more likely to die than black military affiliates. By contrast, control variables lessen this effect, with a reduction to 68 % odds upon demographic controls, 45 % odds upon SES controls, and 26 % odds (at marginal significance) when health controls are added in Model 4. Notably, black military infants are no more likely to die than white civilians, although the lack of significance may stem from small sample size.

In Fig. 3, we graph predicted probabilities of the interaction between race and military affiliation to illustrate their marginal effects when the rest of the control variables from Model 4 are held at their means. This figure demonstrates our basic findings visually. Controlling for maternal and pregnancy characteristics, socioeconomic status, and health-related factors, an unexplained racial gap in infant mortality risk persists in the military, largely because white military affiliates are also so much less likely than white civilians to experience this outcome. Even after these controls are added, military affiliates still have notably improved outcomes compared to their same-race black women.

Because mortality is rare in a sample of this size, we also investigate the closely related and more commonly occurring outcome of preterm birth. To assess the impact of preterm birth on infant death, returning to Model 5 in Panel A, we introduce two variables indicating whether the birth occurred very early or moderately early. These variables are the largest predictors in the final model and explain all of the difference between black military affiliates and civilians, and about half of the difference between black and white military affiliates. Because preterm birth is so highly correlated with infant mortality, we examine the relationship of preterm birth severity and military affiliation in Table 3.

Table 3 shows the two outcome categories of the multinomial regression predicting the likelihood of: (a) severe preterm and (b) moderate preterm birth, both as compared to the probability of a full-term birth outcome. The results indicate a within-race protective association of military affiliation in the risk of both types of preterm birth, although racial disparities among military women persist. Focusing on Outcome 1 first, predicting severe preterm, white military affiliates and civilians, respectively, have a 63 and 54 % reduced risk compared to black military women. The differences reduce slightly with the inclusion of SES controls, but then increase again once the full controls are added. Still, this is a notable reduction from white disparities with black civilians. Separate models switching out the comparison category in the race-military affiliation dummy variables show that black civilians are almost twice as likely as white civilians and affiliates to have a severe preterm birth. Furthermore, the risk of severe preterm birth does not differ among white women in any of the models as it did in the infant mortality models.

Figure 4 shows predicted probabilities of the interaction between race and military affiliation to illustrate their marginal effects when the rest of the control variables from Model 3 are held at their means. The figure shows a continued but reduced racial disparity among military affiliates.

Black civilians are more at risk of delivering a preterm birth than black military affiliates. They still experience a

Table 3 Multinomial logistic regression predicting severity of preterm birth

Independent variables	Model 1		Model 2		Model 3		Model 4	
	Coff.	SE	Coff.	SE	Coff.	SE	Coff.	SE
A. Outcome 1 = severe preterm								
Black civilian	0.45***	0.12	0.46***	0.13	0.27*	0.13	0.13	0.14
White civilian	−0.77***	0.13	−0.73***	0.13	−0.75***	0.13	−0.91***	0.14
White military	−1.0***	0.28	−0.98***	0.28	−0.89***	0.28	−1.03***	0.28
Comparison: black military								
Maternal and pregnancy demographics								
Mother's age								
<20			0.07*	0.04	−0.16***	0.04	−0.13***	0.05
20–29 (omitted)								
30–34			0.09**	0.04	0.28***	0.04	0.28***	0.04
35+			0.35***	0.04	0.54***	0.04	0.48***	0.05
Birth parity								
1st birth			0.51***	0.02	0.60***	0.03	0.83***	0.04
Year of birth			−0.00	0.00	0.00	0.00	−0.01+	0.01
Short birth interval			0.52***	0.04	0.53***	0.04	0.57***	0.05
Male birth			0.15***	0.03	0.15***	0.03	0.15***	0.03
Region								
Southeast (omitted)								
Northeast			−0.16***	0.04	−0.15***	0.04	0.04	0.04
Midwest			−0.15***	0.03	−0.15***	0.03	0.01	0.04
Southwest			−0.059	0.05	−0.08	0.05	0.10	0.05
West			−0.21***	0.07	−0.18**	0.07	0.07	0.07
Socioeconomic factors								
Education								
College degree					−0.40***	0.04	−0.34***	0.05
Associates degree					−0.17***	0.04	−0.17***	0.04
High school graduate (omitted)								
No high school degree					0.14***	0.04	0.14***	0.04
Welfare assistance					0.09*	0.04	0.06+	0.04
Financial hardship					0.10***	0.03	0.07*	0.03
Married					−0.22***	0.04	−0.23***	0.04
Medicaid insurance					0.10***	0.04	0.11**	0.04
Health-related factors								
Prenatal care utilization								
Inadequate							0.81***	0.05
Adequate								
Intermediate (omitted)							−0.28***	0.08
Plus							1.67***	0.03
Prenatal care quality								
Scheduling Inflexibility							0.26***	0.03
Consultation Thoroughness							−0.06***	0.11
Smoked during pregnancy							0.17***	0.04
Mother's prepregnancy weight								
Underweight							0.20***	0.04
Normal weight (omitted)								
Overweight							−0.05	0.04
Obese							0.36***	0.04

Table 3 continued

Independent variables	Model 1		Model 2		Model 3		Model 4	
	Coff.	SE	Coff.	SE	Coff.	SE	Coff.	SE
Adequate pregnancy weight gain							−0.67***	0.03
Hypertensive during pregnancy							0.87***	0.04
Had a previous low weight birth							1.31***	0.04
Stressful events								
Emotional incidents							−0.07*	0.03
Partner-related incidents							−0.04	0.03
Traumatic incidents							−0.10	0.04
Relocated							−0.12***	0.03
Abuse incidents							0.01	0.05
B. Outcome 2 = moderate preterm								
Black civilian	0.21+	0.12	0.17+	0.12	0.03	0.13	0.01	0.14
White civilian	−0.25+	0.14	−0.23+	0.13	−0.28*	0.13	−0.38**	0.14
White military	−0.44**	0.17	−0.38*	0.17	−0.35*	0.17	−0.44*	0.18
Comparison: black military								
Maternal and pregnancy demographics								
Mother's age								
<20			0.06+	0.03	−0.07+	0.04	−0.07+	0.04
20–29 (omitted)								
30–34			−0.01	0.03	0.09***	0.03	0.10**	0.03
35+			0.15***	0.03	0.25***	0.04	0.21***	0.04
1st birth			0.17***	0.03	0.23***	0.03	0.33***	0.03
Year of birth			0.02***	0.00	0.02***	0.00	0.02***	0.00
Short birth interval			0.28***	0.04	0.26***	0.04	0.29***	0.04
Male birth			0.07***	0.02	0.07***	0.02	0.06**	0.02
Region								
Southeast (omitted)								
Northeast			−0.25	0.03	−0.24***	0.03	−0.04	0.04
Midwest			−0.08	0.03	−0.08**	0.03	0.10**	0.03
Southwest			−0.13	0.04	−0.14***	0.04	0.04	0.05
West			−0.27	0.04	−0.26***	0.04	0.01	0.04
Socioeconomic factors								
Education								
College degree					−0.10***	0.03	−0.05	0.04
Associates degree					−0.05	0.03	−0.04	0.03
High school graduate (omitted)								
No high school degree					0.16***	0.03	0.16***	0.04
Financial hardship					0.16***	0.02	0.12***	0.03
Married					−0.05+	0.03	−0.03	0.03
Government assistance					0.10***	0.03	0.09**	0.03
Health-related factors								
Prenatal care utilization								
Inadequate							0.97***	0.04
Adequate (omitted)								
High							−0.10+	0.06
Overexpected							1.81***	0.03
Prenatal care quality								
Scheduling inflexibility							0.08**	0.03

Table 3 continued

Independent variables	Model 1		Model 2		Model 3		Model 4	
	Coff.	SE	Coff.	SE	Coff.	SE	Coff.	SE
Consultation thoroughness							−0.01**	0.00
Smoked during pregnancy							0.09**	0.03
Mother's prepregnancy weight								
Underweight							0.22***	0.03
Normal weight (omitted)								
Overweight							−0.03	0.04
Obese							−0.08**	0.03
Adequate pregnancy weight gain							−0.04+	0.02
Hypertensive during pregnancy							0.90***	0.04
Had a previous low weight birth							1.05***	0.04
Stressful events							0.02	0.02
Emotional incidents								
Partner-related incidents							−0.04	0.03
Traumatic incidents							−0.02	0.03
Relocated							−0.04	0.02
Abuse incidents							0.10*	0.05

+ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

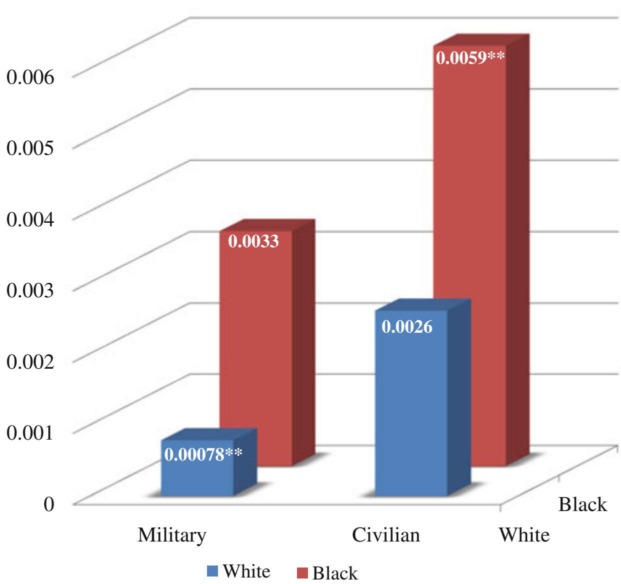

Fig. 3 Odds of infant death: predicted probabilities at variable means by race and military affiliation status. **$p < 0.01$ differences from black military. *Note* represents marginal odds when all control variables from Table 2, Model 4 are held at their means

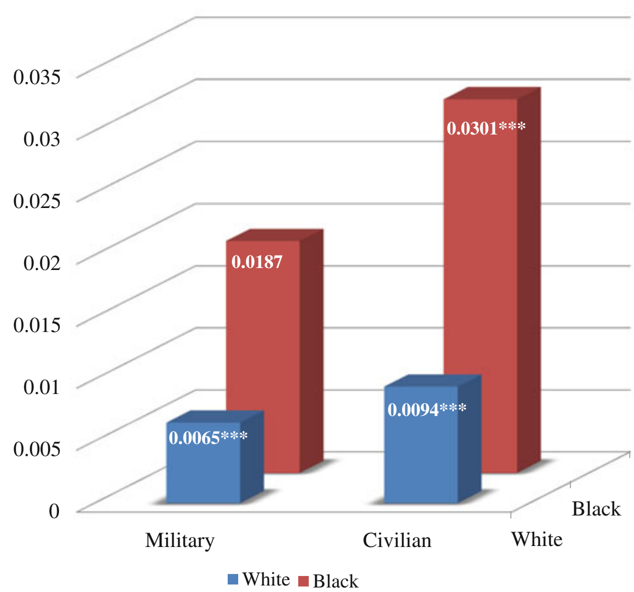

Fig. 4 Odds of very preterm birth predicted probabilities at variable means by race and military affiliation status. ***$p < 0.001$ differences from black military. *Note* represents marginal odds when all control variables from Table 3, Model 3 are held at means

58 % greater odds when demographic controls are entered, which reduces to 31 % when SES differences are accounted for. The military advantage disappears upon the full models.

Turning to Outcome 2, the risk of moderate preterm birth, the results are generally similar, except the overall effects are smaller in magnitude. In Models 1 and 2, black affiliates experience a lower (marginally

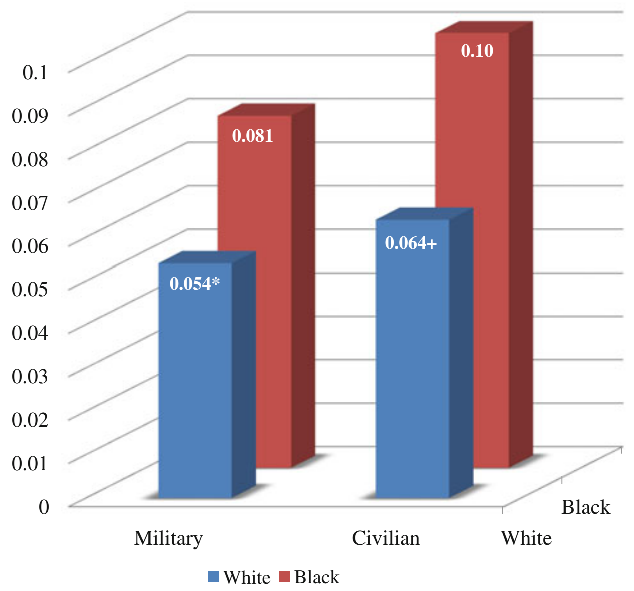

Fig. 5 Odds of moderate preterm birth predicted probabilities at variable means by race and military affiliation status. $*p < 0.05$, $^{+}p < 0.10$ differences from black military. *Note* represents marginal odds when all control variables from Table 3, Model 2 are held at means

significant) risk than their black civilian counterparts. We graph the marginal effects of military affiliation and race in Fig. 5 from Model 2. Racial disparities among both military affiliates and civilians are similar, as military-related improvements are equal across white and black affiliates.

Their advantage in moderate preterm birth disappears upon the inclusion of SES controls (Model 3). As with severe preterm birth outcomes, there is no significant difference between whites. Although racial disparities are not as large as those between white groups and black civilian women, white groups are still between 30 and 35 % less at risk than black military affiliates for delivering a moderate preterm birth even once all controls are accounted for. The controls explain little of this race gap, and, in fact, widen slightly for military women when health controls are controlled for.

Discussion

We hypothesized that the black–white gap in the risk of adverse birth outcomes should be smaller in the military than in civilian life and may disappear once we control for compositional differences in demographics, SES, and health factors. In fact, we do not find this. Our results show that there is a negative association between adverse birth outcomes and military affiliation for *both* white and black women. Thus, the black–white infant mortality gap persists in the military even though black affiliates experience significant improvement in outcomes relative to their same-race civilian counterparts. The black–white disparity is only somewhat lessened in the military setting as a result.

We know from Table 1's descriptive statistics that white affiliated women are more advantaged than each of the other groups in a number of ways. But when we successively control for each of these attributes across the models in Table 2, the variables explain only about a quarter of their lower death risk. White military affiliates' advantage over white civilian women is not as strong in preterm birth outcomes, however. Both groups of white women have more similar risks of moderate and preterm birth (both of which are lower than the risk that black women experience for preterm birth).

As for black military affiliates, we find that their advantage over black civilians in infant mortality largely relates to the lessened negative effect of lower education among military affiliates. There also remains a small, unexplained advantage in the risk of infant mortality for black military women that our controls do not explain.

Why do our controls fail to fully explain military effects? Military enlistees (although less so their families) are subject to rules and regulations that may influence their behavior in a number of domains. These guidelines may have an overall disciplining influence on military life that provides some unmeasured behavioral health advantages. There is also a strong network of formal and informal community support for military families, which may provide higher levels of social support and cohesion during transitions, such as pregnancy and birth. This may be why we find that typical predictors of adverse birth outcomes, like low maternal education and inadequate utilization of prenatal care, do not have the same deleterious association in the military setting as they do in the civilian setting.

As regards preterm birth, we find that military-affiliated black women have improved outcomes compared to civilian women. Unlike in predicting infant mortality, this is completely explained by our control variables, namely that low maternal education and inadequate utilization of prenatal care exerts less of a detrimental impact in the context of a military community setting. It is notable that characteristics that may reflect selectivity of enlistment (premilitary SES, health factors, age, etc.) explain more of the military advantage for black women than for white women. This suggests that there may be more unobserved heterogeneity processes in operation for white military affiliates, although it is not clear why these selectivity processes would differ by race.

The obvious question remains: Why, if the military allegedly provides more equitable SES, access to better health conditions, and an alternative to residential segregation as has been argued, does there persist an unexplained race gap in birth outcomes in the military? While we were surprised that the race gap was still so prevalent in the military setting, we speculate as to why. Although the military strives to be egalitarian for the purposes of manpower readiness, civilian society still interacts and bleeds into military life. Full socioeconomic equality is likely to be an unrealistic assumption in the armed forces; as Table 1 shows, it is simply improved compared to civilian life. Thus, the race gap in the risk of adverse birth outcomes would be expected to lessen but not disappear. Second, families typically do not become affiliated with the military until young adulthood. Most individuals affiliated with the military have lived their formative years outside the military. Thus, early life exposures to lack of health care and other health eroding SES disadvantages from prior civilian life can place mothers at an elevated risk of a preterm birth later in life. Some antecedent clinical factors that contribute to severe preterm birth (e.g., infection, premature labor, preterm rupture of membranes, incompetent cervix, etc.) may be less influenced by prenatal care and more by preconception health conditions (Goldenberg and Rouse 1998).

Limitations

Although our data source allows us to examine the military's impact on racial disparities in infant outcomes in more detail than existing sources, we note several limitations. First, it would have been preferable to distinguish between soldiers and spouses of soldiers, which we are unable to do with the PRAMs data. Second, a number of additional control variables may have been able to shed more light on our findings. For example, our stress measures lack reported exposure to racial discrimination. Prior studies have found a link between experiences of racism and poor health outcomes for black women, including increased prevalence of low birth weight (Paradies 2006). It is possible that, in addition to more equalized economic opportunity in the military, there is also reduced racial discrimination, which is contributing toward more positive health outcomes. Indeed, some studies have found that black soldiers report lesser levels of discrimination from their Army unit than from the civilian world (Dempsey and Shapiro 2009). Unfortunately, we have no direct measures of exposure to racism in the military or civilian life in our own data that could shed light on this possibility.

Furthermore, it would have been beneficial to have early life measures of many of our variables, such as wealth and childhood SES. We also would have liked to have been able to gauge the graded influence of the military's possible protective advantages on the life course of these women. For example, do women who remain affiliated with the military for a significant portion of their lives have superior outcomes to women who are affiliated for only a few years? Unfortunately, we know only whether someone had military insurance or gave birth in a military hospital at the time of survey, not their length of affiliation. Given the significant long-term health impacts of early life experiences, an ideal study population would be children born to career military personnel who spent the first 18 years of their lives in the military environment compared to same-age civilian counterparts.

Conclusion

This article is an important step in identifying the US military environment as a test case for how an alternative setting may influence reproductive outcomes among black women. We find that infant mortality and preterm births among black women are substantially reduced in the military compared to civilian life, a finding that has implications beyond the military and provides insights regarding the extent to which African American infant outcomes are shaped by social context. Although the racial disparity remains in the military setting, it appears that this is, in part, because military whites also benefit in similar ways from military service.

We believe that the military context deserves more scholarship as regards racial disparities in health outcomes. Future research could extend our findings by differentiating how effects vary by soldier and military family status, as well as by military rank. Sorting out the role of unobserved selectivity and why and how this may vary by race is a major challenge, but one that could be improved upon with longitudinal data.

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Appendix

See Table 4.

Table 4 Independent variable measurements

Regression variable	How measured
Maternal and pregnancy factors	
Maternal age	
< 20	Dummy = 1 if mother was less than 20 at birth
20–29 (omitted)	Dummy = 1 if mother was between 20 and 29 at birth
30–35	Dummy = 1 if mother was between 30 and 35 at birth
36+	Dummy = 1 if mother was 36 or older at birth
First birth	Dummy = 1 if mother's first birth
Year of birth	Continuous = 1995–2005 year of birth
Short birth interval	Dummy = 1 if < than 2 years between births (mothers with no previous birth coded to 0 and controlled for by first birth variable)
Male birth	Dummy = 1 if mother had a boy
Southeast	Dummy = 1 if state is AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV
Northeast	Dummy = 1 if state is CT, MA, ME, NH, VT, DE, MD, NJ, NY, PA, YC
Midwest	Dummy = 1 if state is IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI
Southwest	Dummy = 1 if state is AZ, NM, OK, TX
West	Dummy = 1 if state is CO, ID, MT, NV, UT, WY, AK, CA, HI, OR, WA
Infant age at interview	Continuous = age at survey
Socioeconomic factors	
Education	
College degree	Dummy = 1 if mother had college degree at birth
Associates degree	Dummy = 1 if mother had only an associate degree at birth
High school degree	Dummy = 1 if mother had only a high school degree at birth
No high school degree (omitted)	Dummy = 1 if mother had less than a high school degree at birth
Government assistance	Dummy = 1 if mother received some sort of assistance in 12 months prior to birth. This includes receiving temporary assistance for needy families (TANF), WIC, food stamps, supplemental security, and medicaid coverage
Married	Dummy = 1 if mother was married at birth
Financial stressors	Dummy = 1 if mother or partner lost a job or if could not pay bills during the 12 months before birth
Health-related factors	
Adequacy of prenatal care utilization index	Index = 1–4 developed by Kotelchuk 1994, which divides the respondent's total number of prenatal visits by the number of visits suggested by the American College of Obstetricians and Gynecologists (ACOG) and adjusts for the trimester timing of those visits
PNC inadequate	Dummy = 1 if mother reported less than 50 % of expected visits
PNC intermediate	Dummy = 1 if mother reported between 50 and 79 % of expected visits
PNC high (omitted)	Dummy = 1 if mother reported between 80 and 109 % of expected visits
PNC over expected	Dummy = 1 if mother reported 110 % or more of expected visits
Prenatal care quality	
Scheduling inflexibility	Dummy = 1 if mother was unable to schedule her prenatal care as early in her pregnancy as she wanted
Consultation thoroughness	Continuous = 1–11 variable is additive by each topic discussed by medical personnel at prenatal care visits: smoking, alcohol consumption, illegal drug use, seat belt safety, partner abuse, breastfeeding, postnatal birth control methods, unsafe medicines, etc.
Smoked during pregnancy	
Weight gain adequate	Dummy = 1 if mother had a normal pregnancy weight, controlling for her prepregnancy BMI and for stage of pregnancy at birth
Hypertension while pregnant	Dummy = 1 if mother had hypertension

Table 4 continued

Regression variable	How measured
Prepregnancy weight	
Normal weight (omitted)	Dummy = 1 if mother's body mass index was between 18.5 and 25
Underweight	Dummy = 1 if mother's body mass index was less than 18.5
Overweight	Dummy = 1 if mother's body mass index was between 25.1 and 30
Obese	Dummy = 1 if mother's body mass index was greater than 30
Had a previous low weight birth	Dummy = 1 if mother's previous birth was low weight (mothers with no previous birth coded to 0 and controlled for by first birth variable)
Stressful events	
Emotional incidents	Dummy = 1 if a family member had been hospitalized or if someone close had died during the 12 months before birth
Partner-related incidents	Dummy = 1 if there was marital conflict, separation or divorce, or if the partner had not wanted the baby during the 12 months before birth
Traumatic incidents	Dummy = 1 if mother experienced homelessness, a physical fight, incarceration of her partner or herself, and a drinking or substance abuse problem for someone close to her in the 12 months before birth
Relocated	Dummy = 1 if the mother had changed residence during the 12 months before birth
Abuse incidents	Dummy = 1 if the mother experienced physical violence from her partner and/or someone else 12 months before birth

References

Adams, M. M., Read, J. A., Rawlings, J. S., Harlass, F. B., Sarno, A. P., & Rhodes, P. H. (1993). Preterm delivery among black and white servicewomen in the United States Army. *American Journal of Obstetrics and Gynecology, 81*, 65–71.

Barfield, W., Wise, P., Rust, F., Gould, J., & Gortmaker, S. (1996). Racial disparities in outcomes of military and civilian births in California. *Archives of Pediatrics and Adolescent Medicine, 150*, 1062–1067.

Behrman, R. E. (Ed.). (2007). *Committee on preterm birth institute of medicine book "preterm birth": Preterm birth: Causes, consequences, and prevention*. Washington, DC: National Academies Press.

Berg, C. J., Wilcox, L. S., & d'Almada, P. J. (2001). The prevalence of socioeconomic and behavioral characteristics and their impact on very low birth weight in black and white infants in Georgia. *Maternal and Child Health Journal, 5*, 75–84.

Buekens, P., Kotelchuck, M., Blondel, B., Kristensen, F. B., Chen, J. H., & Masuy-Stroobant, G. (1993). A comparison of prenatal care use in the United States and Europe. *American Journal of Public Health, 83*, 31–36.

Burland, D., & Lundquist, J. (2013). The best years of our lives: Military service, family relationships, and the life course. In J. Wilmoth & A. London (Eds.), *Life course perspectives on military service*. New York, NY: Routledge.

CensusScope. (2011). http://www.censusscope.org/2010Census.

Chomitz, V. R., Cheung, L. W. Y., & Lieberman, E. (1995). The role of lifestyle in preventing low birth weight. *Low Birth Weight, 5*, 121–138.

Cramer, J. (1995). Racial and ethnic differences in birth weight: The role of income and financial assistance. *Demography, 32*, 231–247.

Crissey, S. R. (2009). *Educational attainment in the United States: 2007*. U.S. Census Bureau. Retrieved from http://www.census.gov.

Crockett, S. A. (2000). *Race and the census: Interracial marriages more common here because of military*. Virginian-Pilot, A1.

Culhane, J. F., Rauh, V. A., McCollum, K., Elo, I., & Hogan, V. (2002). Exposure to chronic stress and ethnic differences in rates of bacterial vaginosis among pregnant women. *American Journal of Obstetrics and Gynecology, 187*, 1272–1276.

David, R., & Collins, J. (2007). Disparities in infant mortality: What's genetics got to do with it? *American Journal of Public Health, 97*, 1191–1197.

Dempsey, J. K., & Shapiro, R. (2009). The army's Hispanic future. *Armed Forces & Society, 35*, 526–561.

DeNavas-Walt, C., Proctor, B. D., & Smith, J. C. (2010). *Income, poverty, and health insurance coverage in the United States: 2009*. Washington, DC: U.S. Government Printing Office.

Department of Defense. (2008). *The tenth quadrennial review of military compensation*. Retrieved from http://www.defense.gov/news/QRMCreport.pdf.

Department of Health and Human Services. (2008). CDC pregnancy risk assessment monitoring system (PRAMS): Phase 5 (2004–2008) core questions and phase 5 (2004–2008) standard questions. Retrieved from http://www.cdc.gov/prams/questionnaire.htm.

Farley, R., & Frey, W. (1994). Changes in the segregation of whites from blacks during the 1980s: Small steps toward a more integrated society. *American Sociological Review, 59*, 23–45.

Frieden, T. R. (2011). *Forward: CDC health disparities and inequalities report-United States, 2011*. Morbidity and mortality weekly report. Surveillance summaries (Washington, DC: 2002), Vol. 60, p. 1.

Geronimus, A. T. (2001). Understanding and eliminating racial inequalities in women's health in the United States: The role of the weathering conceptual framework. *Journal of the American Medical Women's Association, 56*, 133–136.

Goldenberg, R. L., & Rouse, D. J. (1998). Prevention of preterm birth. *New England Journal of Medicine, 339*, 313–320.

Guendelman, S., & Abrams, B. (1995). Dietary intake among Mexican American women: Generational differences and a comparison with white non-Hispanic women. *American Journal of Public Health, 85*, 20–25.

Hershfield, D. (1985). Attacking housing discrimination: Economic power of the military in desegregating off-base rental housing. *American Journal of Economics and Sociology, 44*, 23–28.

Hocher, B., Slowinski, T., Stolze, T., Pleschka, A., Neumayer, H.-H., & Halle, H. (2000). Association of maternal G protein beta-3 subunit 825T allele with low birth weight. *Lancet, 355*, 1241–1242.

Hogan, P. F., & Seifert, R. F. (2010). Marriage and the military: Evidence that those who serve marry earlier and divorce earlier. *Armed Forces & Society, 36*, 420–438.

Hummer, R. A. (1993). Racial differences in infant mortality in the U.S.: An examination of social and health determinants. *Social Forces, 72*, 529–554.

Hummer, R. A., Biegler, M., De Turk, P. B., Forbes, D., Frisbie, W. P., Hong, Y., et al. (1999). Race/ethnicity, nativity, and infant mortality in the United States. *Social Forces, 77*, 1083–1118.

Institute of Medicine. (2003). *Unequal treatment: Confronting racial and ethnic disparities in health care*. B. D. Smedley, A. Y. Stith, & A. R. Nelson (Eds). Washington, DC: National Academy Press.

LaVeist, T., Thorpe, R. J., Galarraga, J. E., Bower, K. M., & Gary-Webb, T. L. (2009). Environmental and socio-economic factors as contributors to racial disparities in diabetes prevalence. *Journal of General Internal Medicine, 24*, 1144–1148.

Liu, G. G. (1998). Birth outcomes and the effectiveness of prenatal care. *Health Services Research, 32*, 6.

Lu, M. C., & Lu, B. C. (2004). Racial and ethnic disparities in preterm birth: The role of stressful life events. *American Journal of Obstetrics and Gynecology, 191*, 691–699.

Lundquist, J. H. (2004). When race makes no difference: Marriage and the military. *Social Forces, 83*(2), 1–28.

Lundquist, J. H. (2006). The black-white gap in marital dissolution among young adults: What can a counterfactual scenario tell us? *Social Problems, 53*(3), 421–441.

Lundquist, J. H. (2008). Reevaluating ethnic and gender satisfaction differences: The effect of a meritocratic institution. *The American Sociological Review, 73*(3), 477–496.

Lundquist, J. H. & Smith, H. (2005). Family formation in the U.S. military: Evidence from the NLSY. *Journal of Marriage and the Family, 67*, 1–13.

MacDorman, M. F., & Mathews, T. J. (2011). *Understanding racial and ethnic disparities in U.S. infant mortality rates*. NCHS Data Brief, No 74. National Center for Health Statistics, Hyattsville, MD.

MacLean, A., & Elder, G. H, Jr. (2007). Military service in the life course. *Annual Review of Sociology, 33*, 175–196.

Mare, R., & Winship, C. (1984). The paradox of lessening racial inequality and joblessness among black youth: Enrollment, enlistment and employment, 1964–1981. *American Sociological Review, 49*, 39–55.

Martin, J. A., Kung, H. C., Mathews, T. J., Hoyert, D. L., Strobino, D. M., & Guyer, B. (2008). Annual summary of vital statistics: 2006. *Pediatrics, 4*, 788–801.

Moore, B. (2002). The propensity of junior-enlisted personnel to remain in today's military. *Armed Forces and Society, 28*, 257–278.

Moskos, C., & Butler, J. (1996). *All that we can be: Black leadership and racial integration the army way*. New York: Basic Books.

Moster, D., Lie, R. T., & Markestad, T. (2008). Long-term medical and social consequences of preterm birth. *New England Journal of Medicine, 359*, 262–273.

National Institutes of Health. (1998). *Women of color health data book: Adolescents to seniors*. Bethesda, MD: Office of Research on Women's Health, National Institutes of Health NIH Publication 98-4247.

Office of Management and Budget. (2007). *Budget of the United States government, fiscal year 2007*. Retrieved from http://www.whitehouse.gov/omb/budget/fy2007/defense.html.

Office of the Deputy Under Secretary of Defense. (2005). *2005 Demographics report*. http://cs.mhf.dod.mil/content/dav/mhf/QOL-Library/PDF/MHF/QOL%20Resources/Reports/2005%20Demographics%20Report.pdf.

Rawlings, J. S., & Weir, M. R. (1992). Race- and rank-specific infant mortality in a U.S. military population. *American Journal of Diseases of Children, 146*, 313–316.

Reagan, P. B., & Salsberry, P. J. (2005). Race and ethnic differences in determinants of preterm birth in the USA: Broadening the social context. *Social Science and Medicine, 60*, 2217–2228.

Sampson, R., & Laub, J. (1996). Socioeconomic achievement in the life course of disadvantaged men: Military service as turning point, circa 1940–1965. *American Sociological Review, 61*, 347–367.

Sastry, N., & Hussey, J. M. (2003). An investigation of racial and ethnic differences in birth weight in Chicago neighborhoods. *Demography, 40*, 701–725.

Schoendorf, K. C., Hogue, C. J. R., Kleinman, J. C., & Rowley, D. (1992). Mortality among infants of Black as compared with white college-educated parents. *New England Journal of Medicine, 326*, 1522–1526.

Seeborg, M. C. (1994). Race, poverty and enlistment: Some evidence from the national longitudinal survey of youth. *The Journal of Economics, 1*, 15–24.

Siffert, W., Naber, C., Walla, M., & Ritz, E. (1999). G protein beta 3 subunit 825T allele and its potential association with obesity in hypertensive individuals. *Journal of Hypertension, 17*, 1095–1098.

Taylor, P., Fry, R., & Kochhar, R. (2011). *Wealth gaps rise to record highs between whites, blacks, Hispanics*. Retrieved from http://www.pewsocialtrends.org/2011/07/26/wealth-gaps-rise-to-record-highs-between-whites-blacks-hispanics.

Teachman, J. (2009). Military service, race, and the transition to marriage and cohabitation. *Journal of Family Issues, 30*, 1433–1454.

Thorpe, R. J, Jr, Brandon, D. T., & LaVeist, T. A. (2008). Social context as an explanation for race disparities in hypertension: Findings from the exploring health disparities in integrated communities (EHDIC) study. *Social Science Medicine, 67*, 1604–1611.

United States Census Bureau. (2010). Table 626 Unemployment Rates by Race. http://www.census.gov/compendia/statab/2011/tables/11s0626.pdf.

U.S. Department of Health and Human Services. (2010). (Objective 16-1) *Tracking healthy people 2010*. Washington, DC: Government Printing Office.

Varner, M. W., & Esplin, M. S. (2005). Current understanding of genetic factors in pre-term birth. *British Journal of Obstetrics and Gynaecology, 112*, 28–31.

Van den Oord, E., & Rowe, D. C. (2000). Racial differences in birth health risk: A quantitative genetic approach. *Demography, 37*, 285–298.

Van den Oord, E. J., & Rowe, D. C. (2001). A step in another direction: Looking for maternal genetic and environmental effects on racial differences in birth weight. *Demography, 38*, 573–576.

Ventura, S. J. (2009). *Changing patterns of nonmarital childbearing in the United States*. NCHS Data Brief, No. 18. National Center for Health Statistics, Hyattsville, MD.

Vintzileos, A. M., Ananth, C. V., Smulian, J. C., Scorza, W. E., & Knuppel, R. A. (2002). The impact of prenatal care in the United States on preterm births in the presence and absence of antenatal high-risk conditions. *American Journal of Obstetrics and Gynecology, 187*, 1254–1257.

Wahl, C. K., & Rundall, V. F. (1996). Military women as wives and mothers. *Women's Health Issues, 6*, 315–319.

Webb, J. (1997). The war on the military culture. *The Weekly Standard, 2*, 17–22.

Wilcox, A. J., & Russell, I. T. (1986). Birthweight and perinatal mortality: III. Toward a new method of analysis. *International Journal of Epidemiology, 15*, 188–196.

Williams, D. R., & Sternthal, M. (2010). Understanding racial/ethnic disparities in health: Sociological contribution. *Journal of Health and Social Behavior, 51*, S15.