BIRTH OUTCOMES FOR ARABIC-NAMED WOMEN IN CALIFORNIA BEFORE AND AFTER SEPTEMBER 11*

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Persons who were perceived to be Arabs experienced a period of increased harassment, violence, and workplace discrimination in the United States in the weeks immediately following September 11, 2001. Drawing on prior studies that have hypothesized that experiences of discrimination increase the risk of preterm birth and low birth weight, this study explores whether there was an effect on birth outcomes for pregnant women of Arab descent. California birth certificate data are used to determine the relative risk of poor birth outcomes by race, ethnicity, and nativity for women who gave birth in the six months following September 2001, compared with the same six calendar months one year earlier. The relative risk of poor birth outcomes was significantly elevated for Arabic-named women and not for any of the other groups.

Over the past 15 years, social epidemiologists have conducted a number of studies to investigate whether experiencing racial or ethnic discrimination has health consequences (literature reviewed in Krieger 1999; Williams, Neighbors, and Jackson 2003). Studies have investigated diverse health outcomes, including depression, hypertension, and self-rated health. The underlying conceptual model is that perceiving an experience as discrimination triggers a psychological and physiological stress response that can deleteriously affect health (Clark et al. 1999; Hogue, Hoffman, and Hatch 2001). One health domain that has received increased attention recently is poor birth outcomes, either low birth weight or preterm birth (Collins et al. 2004; Collins et al. 2000; Dole et al. 2003; Dole et al. 2004; Jackson et al. 2001; Murrell 1996; Mustillo et al. 2004; Rich-Edwards et al. 2001; Rosenberg et al. 2002). Birth outcomes are a compelling health outcome for studies of discrimination for several reasons. Poor birth outcomes are relatively common and have potentially serious consequences, there are significant and unexplained social disparities in preterm birth, pregnancy is of short duration and likely represents a critical period for determining birth outcomes, and a candidate biological mechanism links the physiological stress response to preterm birth.

The candidate biological mechanism involves increased production of the neuropeptide corticotropin-releasing hormone (CRH), which responds to maternal or fetal stress by increasing production in the placenta (Hobel and Culhane 2003; Lockwood 1999; Wadhwa et al. 2001). CRH levels likely play a role in initiating labor. Women with elevated levels of CRH in the second trimester or early third trimester of pregnancy are at increased risk of having a preterm labor (Hobel et al. 1999; Holzman et al. 2001; McLean et al. 1999; Wadhwa et al. 1998). In one recent study, CRH measured at 33 weeks' gestation predicted both an increased risk of spontaneous preterm birth (relative risk of 3.3) and an increased risk of fetal growth restriction (relative risk of 3.6; Wadhwa et al. 2004). CRH has been shown to be sensitive to maternal psychosocial stress. Maternal age and stress level measured at 18 to 20 weeks' gestation predicted change in CRH from 18–20 to 28–30 weeks' gestation (Hobel et al. 1999). Pregnancy-specific anxiety measured at 28–30 weeks was correlated

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with CRH measured at the same time, and both predicted preterm birth; CRH mediated the relationship between anxiety and preterm birth (Mancuso et al. 2004). These studies that demonstrate the effects of maternal stress or anxiety, measured mid-pregnancy, on CRH and birth outcomes lend plausibility to the hypothesis that experiencing stress related to race during pregnancy could contribute to risk of preterm birth or low birth weight. These studies do not, however, definitively identify the critical time window for when stress experiences affect birth outcomes. Although the data collections have focused on mid-pregnancy reports of stress, it is possible that women who report stress, even pregnancy-related anxiety, at that time would also have reported greater stress over a much longer time frame.

Despite this growing body of evidence that stress affects birth outcomes, epidemiological studies of discrimination experiences and birth outcomes have not consistently found an association. These studies have varied in design (cohort and case-control designs), whether information was collected about discrimination experiences during pregnancy or more generally, and in the actual questions or measurement scales that were used. Murrell (1996) conducted a small study (n = 165) in which pregnant African American women, during a regular visit to a prenatal clinic, were asked about stress and experiences of racism and later followed up on their birth outcomes. Neither stress nor racism, which were significantly correlated, predicted low birth weight or preterm birth. Collins et al. (2000) conducted a hospital-based case-control study of African American mothers who had delivered very low birth weight (< 1,500 grams, n = 25) and non–low birth weight (> 2,500 grams, n = 60) infants. They found that after childbirth, maternal recollection of exposure to discrimination during pregnancy was associated with very low birth weight, with an adjusted odds ratio of 3.2. Rosenberg et al. (2002) conducted a larger study in which African American women of childbearing age were asked about the frequency of nine types of discrimination or racism experiences. Pregnancy information was collected for births within two years before and after the interview. Two of the types of experiences—people being afraid of them at least once a week and unfair treatment on the job—were modestly but significantly associated with preterm birth (odds ratios of 1.4 and 1.3, respectively), but there were no significant associations with the other seven types of experiences. Associations were stronger for women with less education.

Recent studies have more consistently supported a role for experiences of discrimination in birth outcomes (Collins et al. 2004; Dole et al. 2003; Dole et al. 2004; Mustillo et al. 2004). Dole et al. (2003) conducted a prospective study among white and African American women that examined a wide range of psychosocial factors, including perceived discrimination. They found an increased risk of preterm birth among women who reported racial discrimination (a relative risk of 1.4). Among African American women, the relative risk was 1.8 (Dole et al. 2004). Collins et al. (2004) conducted a second, larger case-control study of women, 104 of whom delivered very low birth weight preterm (< 1,500 grams, < 37 weeks) infants and 208 of whom delivered non–low birth weight term infants (> 2,500 grams, 37+ weeks). They explicitly asked the women about both chronic exposure to racial discrimination and exposure during the pregnancy. They found a strong effect for chronic experiences, especially discrimination "at work" and "finding a job," but not for perceived discrimination during pregnancy. However, many women may not have been at risk for experiencing some of the types of discrimination during the short pregnancy period (e.g., "finding a job" or "at school"), and these were rarely reported among both cases and controls.

Despite some negative findings, this group of studies generally supports an effect for experiencing discrimination on birth outcomes. However, important questions remain. First, is there an effect for acute experiences of discrimination during pregnancy, or are chronic experiences really what matter? Previous studies differ in the time frame of the discrimination experiences, in terms of both when the questions were asked (before or after pregnancy) and whether respondents were asked about the experiences they had during the pregnancy or their experiences more generally. Even when questions focus on the

pregnancy period, reports may still reflect chronic exposure. Second, is the effect specific to African Americans, for whom the chronic experience of discrimination in the United States may be unique? Other racial or ethnic groups that might experience discrimination have not been studied. Finally, it is not clear what self-reports of discrimination measure.

Scholars who have conducted these investigations are well aware of the complexities of measuring the experience of discrimination (see, e.g., Krieger 1999; Williams et al. 2003). A key issue is how individual psychological and demographic factors influence either the perception that a stressful experience is related to discrimination or the disclosure of such experiences to the researcher (Meyer 2003). Murrell (1996), for example, found that women who reported more racism were older, better educated, and more likely to be married. She speculated that these relatively privileged women were better able to articulate oppression. A sense of control has been shown to buffer the negative consequences of stressors on mental and physical health (Hogue et al. 2001). Krieger and Sidney (1996) hypothesized that persons who internalize rather than articulate their experiences of discrimination may actually be at greater risk of adverse health outcomes. Psychological characteristics that are likely to influence whether an experience is attributed to racism and whether it is remembered and reported as such in an interview, such as coping style (e.g., distancing oneself from a problem or not talking about unfair treatment) and a tendency to internalize, have themselves been investigated as risk factors for preterm birth and low birth weight (Collins et al. 2000; Dole et al. 2004). If the same psychological factors both cause underreporting of discrimination and worsen birth outcomes, this would be a negative bias in studies.

In the present study, I aim to complement recent research on discrimination and birth outcomes by focusing on a different ethnic group and using a novel study design. This study uses the brief but intense surge in anti-Arab sentiment that followed September 11, 2001 (hereafter referred to as 9/11), to examine whether poor birth outcomes increased for Arab-origin women in the United States who were pregnant at the time, compared with women who were pregnant one year earlier. By focusing on a period effect at the population level, this study circumvents the complexities and ambiguities of subjective reports of discrimination experiences. Also, the design, in effect, controls for lifetime ethnicity-related stress or discrimination by comparing birth outcomes for similar women who gave birth one year apart. The same periods are also compared for other women who gave birth because there may have been a more widespread effect of 9/11 that was not related to ethnicity. California is the focus for the study because it is the state with the largest Arab-origin population and because of data requirements, as described later.

Discrimination Following 9/11

Diverse sources identify the weeks after 9/11 as a period when persons who were perceived to be Arabs in the United States were victims of harassment, hate crimes, and workplace discrimination. Knowledge of and concern with these events was widespread at the time in the Arab American community. The Arab American Institute commissioned Zogby International to poll Arab Americans four weeks after 9/11. The poll reached 508 Arab American likely voters nationwide. Nearly half the respondents said they knew of someone of Arab background who had experienced discrimination since the attack, and 20% had personally experienced discrimination (Zogby International 2001). The American-Arab Antidiscrimination Committee summarized the experience of Arab Americans in the 12 months following 9/11. The committee had received reports of over 700 violent incidents, including several murders, directed toward persons who were perceived to be Arab in the first nine weeks after the attack. In the first 10 months of 2002, reported incidents decreased to 165, although this number exceeded levels in previous years (American-Arab Anti-Discrimination Committee Research Institute 2003).

California also experienced increased discrimination. California's 2001 annual report on hate crimes noted that "anti-other" ethnic hate crimes increased 345.8% (from 96 in

2000 to 428 in 2001), primarily because of anti-Arab incidents after 9/11; there was also an increase in "anti-Muslim" incidents among religiously motivated hate crimes (California Department of Justice 2001). In a December 13, 2001, *Long Beach Press-Telegram* article, the hate crimes prevention coordinator for the Muslim Public Affairs Council in Los Angeles described the effect of these hate crimes on the community: "People are being attacked . . . Even when the numbers are small, the ratio is great. I've noticed a great fear of everyday life. People are afraid to go to work and school. There's been a tremendous backlash. People are nervous and unhappy and it will take quite a while before the feeling goes away" (Young 2001).

The magnitude of the problem was underscored by reaction from the government and press. Government officials and agencies responded with public denunciations of anti-Arab and anti-Muslim violence and discrimination, including a visit by President Bush to the Islamic Center in Washington, DC, on September 17. To counter complaints of employment discrimination and workplace violence, the U.S. Equal Employment Opportunity Commission, the Department of Justice, and the Department of Labor issued a joint statement in November. Violent events were widely and sympathetically covered in the press. An October 10 AP news story described four murders, emphasizing the human tragedy (Kong 2001):

> Abdo Ali Ahmed's 5-year-old son is still waiting for his father to bring him candy and ice cream. Adel Karas was planning a surprise barbecue for his wife to celebrate her certification as an anesthesiologist. Waqar Hasan was shopping for a house, so his wife and four daughters could join him in Dallas. And Balbir Singh Sodhi called his parents in India to reassure them he was safe, far from the violence in New York and Washington . . . All the men were slain while working at their small stores and gas stations, where they spent as many as 16 hours a day. Family and friends say they came to the United States from Yemen, Egypt, Pakistan and India in search of the American dream.

While each pregnant woman of Arab descent in the United States may not have personally experienced discrimination, it seems likely that concern about what might happen would be a widespread stressor, perhaps especially for pregnant women.

Violent events declined by the end of the year. Summarizing the backlash, a 2002 report by the Human Rights Watch (Singh 2002:15) noted that "the violence included murder, physical assaults, arson, vandalism of places of worship and other property damage, death threats, and public harassment. Most incidents occurred in the first months after September 11, with the violence tapering off by December." On December 13, 2001, the communications director of the American-Arab Anti-Discrimination Committee was quoted as saying, "My impression is that we are rapidly returning to what one would unfortunately call a normal amount of hate crimes" (Young 2001). Although incidents declined, levels of fear may not have declined concurrently.

Violence and workplace discrimination appear to have been prominent dimensions of discrimination in this period. Both could potentially affect birth outcomes. Studies of violence and birth outcomes have examined crime levels as contextual variables that explain spatial variation in health (Collins and David 1997; O'Campo et al. 1997; Zapata et al. 1992). Morenoff (2003) found that neighborhood-level violent crime and other mechanisms related to stress and adaptation consistently predicted birth weight and that these contextual influences on maternal health extended beyond the immediate neighborhood. In these studies, crime level was a contextual effect, not a poorly measured surrogate for individual victimization. Thus, the experience of being part of the Arab community in the United States during this period, regardless of whether the community was spatially defined, could have been psychologically similar to temporarily living in a high-crime neighborhood.

Workplace discrimination could also affect birth outcomes through its effects on income. Finch (2003) found that income affects the risk of low birth weight. Using the

nativity information in the Current Population Surveys, Neeraj, Kaestner, and Reimers (2004) found that wages, although not employment, declined for Arabs and Muslims after September 2001.

METHODS

Data Source

The data source is a file of all California birth certificates for 2000, 2001, and 2002; there are about half a million California births each year. This project required birth certificates with names for ethnic identification (as described later). This research was possible because the Center for Health Statistics of the California Department of Health Services has a review process for considering research proposals that require vital records with individual identifiers. Among the data in each birth record are date of birth; mother's given name and maiden name; infant's given name and surname; infant birth weight; gestational age (based generally on reported last menstrual period); mother's race (white, black, American Indian, specific Asian and Pacific Islander groups, and Other); Hispanic ethnicity; type (e.g., singleton, twin); and mother's age, education, marital status, and parity. Maternal birthplace is also available, but most foreign countries are grouped together in a "rest of the world" category. Smoking status during pregnancy is not available. This study includes only singleton births. The protocol was approved by the Committee for the Protection of Human Subjects of the California Health and Human Services Agency, the California State Registrar, and the Institutional Review Board of the University of Chicago.

Identifying Arab Americans

The key challenge to studying the health of persons with Arab origins in the United States is identifying the population: Arab is neither a race category nor an ethnicity category routinely collected in vital statistics or survey data in the United States. The 1978 federal guidelines for the collection of data on race and ethnicity, "Directive 15" of the Office of Management and the Budget, defined the race category "white" as "persons originating in Europe, the Middle East and North Africa"; efforts to add an Arab or Middle Eastern category to the federal standards were not successful in the revision process prior to the 2000 census (Office of Management and Budget 1978; Samhan 1999). Therefore, self-identified Arab ethnicity is not available in birth certificate data. Women who are likely of Arab origin are identified in this study with a recently developed algorithm that uses quantitative information about how predictive a surname and given name are of having origins in Arabic-speaking countries (Morrison et al. 2003). The logic of a group-specific name list is to compile names that are common to members of the group but uncommon to nonmembers. The most widely used application of name-based identification has been the Census Bureau's Spanish surname lists for identifying the Hispanic population (Passel and Word 1980; Word and Perkins 1996).

The name algorithm is empirically based and probabilistic. The surname and given name lists used in this project were derived from the Social Security Administration's file of applications for social security cards, approximately 420 million records. The file is effectively a registry of persons living in the United States since the inception of the social security program in 1936. The derivation of the name lists draws on previous work that used this file to create lists of Asian and Spanish names for demographic research applications (Elo et al. 2004; Lauderdale and Kestenbaum 2000, 2002; Morrison et al. 2003). The record content includes surname, maiden name, given name, race (broadly defined), and country of birth. Because many Arab-origin persons in the United States are foreign-born, country of birth can be used as a proxy for Arab ethnicity. The League of Arab Countries' list of 22 member countries was used, but the Comoros Island was omitted because of relatively few cases and apparent coding problems. Palestine/Israel was also omitted because

Table 1. An Example of Transliterations of an Arabic Surname: Number of Occurrences in the File of Applications for a Social Security Number, and the Number and Percentage With an Arab Birthplace

Transliteration	Number of Occurrences	Number of Occurrences With Arab Birthplace	Percentage With an Arab Birthplace
Al Khalidi	68	36	53
Alkhalidi	40	26	65
Al Khalidy	12	5	42
El Khalidi	11	4	36
Elkhalidi	7	3	43

it would include Jewish names; the Social Security Administration's more-specific codes of Gaza and West Bank were used instead.

The steps in deriving the name lists were as follows. For women, the maiden name, if available, was substituted for the surname to minimize misclassification because of marriage outside the ethnic group. Two skeleton files were drawn from this file to include just the surname (or maiden name) and birthplace in one file and given name and birthplace in the other. Each of the two files was sorted on name and birthplace (simplified to being Arab birthplace versus non-Arab birthplace). A single percentage score for each name indicated what percentage of persons with that name had an Arab birthplace. Lists of surnames and given names that contained all names with at least 1% with Arab birthplace and with at least five occurrences (for confidentiality reasons) were created. Because many Arab Americans are U.S. born, there is no expectation that names that are ethnically quite specific would have a score of 100%. The surname file includes 85,769 names, 41,894 with a score of 20% or higher. The file of given names (which includes both men's and women's names) includes 43,158 names, 14,561 with a score of 20% or higher.

The names in the file were not edited. The file does not include hyphens, but two-word names, such as "Al Khalidi," could appear both with and without a space, depending on how the card applicant wrote the name. Because many Arabic names have variant transliterations into English, different English spellings of the same Arabic name may have different computed probabilities. However, spelling variants were most often similarly predictive of Arab birthplace (see Table 1 for an example). Infrequent spellings and rare names may appear to be unpredictive because there were fewer than five occurrences, and thus no probability was assigned. To validate the lists, Morrison et al. (2003) identified likely Arab Americans by name from lists of registered voters in two locations—the city of Boston and the county of San Diego—and compared their spatial distribution with the spatial distribution of persons with Arab ancestry codes in the 2000 decennial census. For the validation study, a person was classified as likely being of Arab origin if the sum of the person's given name plus surname percentages was 20% or more. The threshold was empirically derived: the number of Arab-origin persons identified in this way by name in paid employment in 1989 as reported on W-2 forms was similar to the number of persons identified by ancestry code as having Arab origins in paid employment in 1989 according to the 1990 census.

A similar approach is taken here to identify likely Arab-origin women using the California birth certificate data: the percentage score for the mother's given name and birth surname (maiden name) are summed. The mother's given name on the birth certificate is truncated at eight characters, and a given-name list was generated for this project to

compute probability scores for truncated names. Women with a sum score above a threshold of 20% are classified as "Arabic-named" women and are presumed to have high likelihood of having Arab origins.

As an indicator of strength of ethnic identity for Arabic-named women, the infant's given name is classified as one that is ethnically distinctive or not. For this classification, the infant's name is considered ethnically distinctive if the score is 20% or higher. (The infant's name is not truncated and includes up to 12 characters.) Correlates of infants who were born in the United States and who have ethnically distinctive given names may be parents' language use, religion, religiosity, immigration year, and social network, as well as paternal ethnicity.

Although name identification is neither perfectly sensitive nor perfectly specific, persons are identified in the same way throughout the study period. Therefore, the Arabic-named women identified in different years should be comparable. Misclassification in either direction would result in underestimating a true contrast between women with Arab origins and other racial and ethnic groups.

Birth Outcomes

Previous studies that have examined whether stressful events or discrimination affect birth outcomes have used low birth weight (< 2,500 grams), very low birth weight (< 1,500 grams), preterm birth (< 37 weeks), or a combination of these classifications (very low birth weight and preterm) as the outcome of interest. The candidate biological mechanism, increased CRH, is hypothesized to affect preterm birth, although one study also found an increased risk of fetal growth restriction (Wadhwa et al. 2004). The majority of low birth weight infants are preterm, so studies of low birth weight primarily reflect preterm birth and secondarily reflect fetal growth restriction of term infants. The mean weight at 37 weeks is 3,000 to 3,100 grams (Zhang and Bowes 1995). Low birth weight has been widely used as an indicator of reproductive health; the Centers for Disease Control and Prevention use low birth weight as one of the metrics to monitor population health (e.g., Iyasu, Tomashek, and Barfield 2002; U.S. Department of Health and Human Services 2000). Low birth weight is associated with increased risk of neonatal death (Gortmaker and Wise 1997) and long-term health effects, including problems in cognitive development (Hack, Klein, and Taylor 1995) and perhaps chronic diseases in adulthood (Barker 1995; Couzin 2002). In the United States, African Americans are at markedly increased risk of low birth weight compared with whites (Martin et al. 2003; Iyasu et al. 2002; U.S. Department of Health and Human Services 2000). Thus, the primary outcome in this study is low birth weight.

Low birth weight has been criticized as a health indicator because it includes both preterm infants and small-for-age term infants. Wilcox (2001) conceptualized this problem by describing birth weights as a mixture of two distributions: a highly normal, term birth-weight distribution and a residual distribution of excess observations on the left tail that includes small, preterm births (Wilcox 2001). Thus, two different scenarios—either many small preterm infants or a lower mean term birth weight—could result in one population having a higher proportion low birth weight than another population. These two situations have different consequences for mortality risk. Populations with lower mean term birth weight do not have higher mortality risk. Thus, Wilcox considered low birth weight an unreliable marker of mortality risk.

The attraction of low birth weight as a research outcome when data from birth certificates are used is that the birth weight data are complete and highly accurate, whereas data on gestational age from birth certificates is neither (Piper et al. 1993; Reichman and Hade 2001). Gestational age on the birth certificate is generally based on the mother's report of last menstrual period. In the California birth certificates used in this study, internal evidence suggests that the data on gestational age are problematic. Almost 10% of the records do not have a usable gestational age because it is either missing or implausibly greater than

44 weeks. Births with missing gestational age are nearly twice as likely to be low birth weight. Further, it is likely that many infants with a gestational age of less than 37 weeks are unlikely to actually be preterm, based on their high birth weight. However, very few of these records can be individually identified and corrected. For example, the 90th percentile for singleton white males of 35 weeks' gestation with primapara mothers has been estimated at 3,375 grams (Zhang and Bowes 1995). However, 18% of such 35-week infants in the California birth certificates fall above that 90th percentile. Because few of the birth weights are so high that the gestational age is truly impossible, one cannot justify reclassifying the infant as a term birth; there are simply too many of these cases at the top of the weight-for-age distribution among preterm births. Thus, there are two problems with a preterm category defined by gestational age on the birth certificate. First, the sample size will be reduced because of missing and impossible gestational ages, and true preterm births will be overrepresented among the excluded records. Second, the preterm group will include a significant proportion of term infants. This misclassification affects a much larger proportion of preterm than term infants because of the relative sizes of the two groups.

Therefore, I use a different approach to examine whether there is a period effect on preterm birth. Wilcox proposed a statistical approach to gleaning information about gestational age by using only birth weight data (Wilcox 2001). His method uses his model of birth weights as a combination of a predominant and a residual distribution. Although some preterm births do not fall in the left tail of the distribution because of their higher weight, Wilcox pointed out that it is the small preterm births that are at the greatest risk of death and disability. Software is available (https://eb.niehs.nih.gov/bwt) to calculate the mean and standard deviation of the predominant distribution and the percentage of births in the residual distribution, given the observed birth weights. I use this method here to determine mean birth weight for the predominant distribution, as well as the percentage of births in the residual distribution, for the non-Hispanic white and the Arabic-named women during the two periods. An additional analysis confirms these results by testing whether the risk of infants being both preterm (using the gestational age on the birth certificate) and small (low birth weight) also varies for non-Hispanic white and Arabic-named women during the two periods. The category of small and preterm largely avoids one of the sources of inaccuracy in the gestational age (term infants in the preterm category) but does not overcome the problem that almost 10% of the records are excluded from the analysis and that these excluded records likely include an excess proportion of preterm births.

Other Variables

The primary maternal race on the birth record is used to classify mothers into one of five racial groups: white, black, Native American, Asian or Pacific Islander, or other (includes missing and persons who do not identify with any racial group). Results by race are not presented for the "other" group. Two ethnicities are also identified: Hispanic and Arab American. The maternal Hispanic-origin code is used to classify women as Hispanic or not. This information is combined with the race code to redefine the racial categories as "non-Hispanic white" and "non-Hispanic black." Hispanic mothers with other race codes are also reclassified as Hispanic, but those combinations are rare. As described earlier, maternal given name and maiden name are used to classify women as likely of Arab origin or not. Arabic-named women are also removed from the other race categories. Other demographic predictors of low birth weight available on the birth certificate are maternal age, maternal education, marital status, and parity. Maternal age is categorized as less than 20, 20–29, 30–34, or 35 years or older. Maternal education is categorized as less than 12, 12, 13–15, 16 or more years, and missing. Parity is dichotomized as first birth or not. Although marital status was directly ascertained for birth certificates during the study period in California, only inferred marital status is included in identifiable records such as those used in this

study. The inference procedure may be differentially accurate across ethnic groups with different conventions about changing one's name at marriage.

Period

Studies that have investigated the effects of stress on preterm birth and birth weight have most often measured stress mid-pregnancy, during the second and early third trimester (Buekens and Klebanoff 2001; Hedegaard et al.1996; Paarlberg et al. 1999; Pritchard and Teo 1994; Rondo et al. 2003; Whitehead et al. 2002). To identify the period over which one might expect to observe an increased risk of low birth weight or preterm birth for Arab-origin women owing to experiences of discrimination during pregnancy, I considered several factors. I defined the population of interest as women who were already pregnant on 9/11 to minimize possible confounding by factors influencing fertility following 9/11 and to insure that the women were pregnant during the period of heightened discrimination. Also, women needed to be at risk of preterm birth, so births immediately after 9/11, most of which would have been among women who were already past 37 weeks' gestation, were excluded. A six-month period from October 1, 2001, through March 31, 2002, was selected (the "post-9/11 period"). Birth outcomes in this period are compared with those that occurred in the corresponding six months one year earlier (October 1, 2000, through March 31, 2001, the "pre-9/11 period"). The corresponding six months a year earlier are used for comparison because there may be seasonal effects on birth weight (Doblhammer and Vaupel 2001). Because of the sample size of Arabic-named women, there is too much variability to examine outcomes month by month.

Analysis

Low birth weight. Logistic regression is used to examine how low birth weight varies by race and ethnicity during a baseline period (January 2000–June 2001). The odds ratio of low birth weight for each racial and ethnic group during the baseline period (compared with non-Hispanic whites) is presented, both unadjusted and adjusted for maternal age, maternal education, parity, and marital status. The baseline multivariate model is a logistic model:

$$\Pr(\text{low birth weight} = 1) = F(\beta_0 + \beta_{1i}\text{race/ethnicity}_i + \beta_{2j}\text{age}_j + \beta_{3k}\text{education}_k + \beta_4\text{parity} + \beta_5\text{married}),$$

where race/ethnicity, age, and education are sets of categorical indicator variables indexed by i, j, and k, respectively. The purpose of the multivariate model is to examine whether the available covariates are confounders of the association between race/ethnicity and low birth weight.

Then the unadjusted relative risk of low birth weight is presented within each racial, ethnic, and nativity group for the post-9/11 period compared with the pre-9/11 period one year earlier. The relative risk is the proportion low birth weight in the post-9/11 period divided by the proportion low birth weight in the pre-9/11 period. Adjusting for the available maternal characteristics has no influence on relative risk estimates because maternal characteristics within each racial/ethnic/nativity group are extremely similar in the pre- and post-9/11 periods. Without the need to adjust for confounders, logistic regression (which yields odds ratios) is unnecessary, and the relative risk is presented. To formally test whether the relative risk differs for Arabic-named mothers compared with non-Hispanic white mothers, I use the Mantel-Haenszel test for homogeneity of the relative risk. For Arabic-named women, a further analysis examines whether the relative risk of low birth weight is greater for women with a stronger ethnic identity, as suggested by naming the infant with a distinctively Arabic given name.

Preterm birth. To compare the risk of preterm birth, I use the Wilcox program (Wilcox 2001) to determine the mean birth weight of the dominant term distribution and the

Table 2. Characteristics of Women Who Gave Birth to Singleton Infants in California in 2000–2002, From Birth Certificate Data

Characteristic	All	Non-Hispanic White	Non-Hispanic Black	Asian and Pacific Islander	Native American	Hispanic	Arabic Named
Number	1,547,375	533,075	90,943	184,805	8,673	716,414	15,064
Age							
< 20	10.3	7.8	15.0	3.9	17.0	13.4	4.3
20–29	49.6	42.6	52.9	40.4	55.2	56.8	49.8
30–34	24.2	28.4	18.8	34.0	17.0	19.1	28.6
35+	16.0	21.2	13.3	21.7	10.9	10.8	17.2
Education							
< 12	29.2	12.3	16.4	9.2	27.8	49.0	11.9
12	28.3	26.9	40.0	21.3	39.8	29.9	25.6
13–15	19.3	24.5	27.7	23.9	22.5	13.3	22.4
16+	21.6	35.3	13.8	44.5	8.8	6.4	37.6
Missing	1.7	1.0	2.1	1.1	1.1	1.3	2.5
First Birth	38.8	43.3	36.6	46.8	34.9	33.8	39.6
Unmarried (inferred)	31.1	26.8	53.8	14.5	42.5	35.8	26.0
Foreign-born	46.2	16.4	6.9	82.8	3.5	63.6	82.3

percentage of births in the residual left-tail distribution (small, preterm births) for Arabic-named women and non-Hispanic white women in each of the two periods. I use a chi-square test to determine whether the proportion in the residual distribution is independent of period for each racial/ethnic group. To confirm the approach based on the birth-weight distribution, I also conduct a second analysis similar to the primary analysis with low birth weight. In the confirmatory analysis, the relative risk of low birth weight *and* preterm births (using the gestational age on the birth certificate for those with possible gestational ages) is compared for Arabic-named women and non-Hispanic white women in the two periods. Whether the relative risks differ is tested with the Mantel-Haenszel test for homogeneity of the relative risk.

RESULTS

Table 2 shows maternal characteristics for each of the racial and ethnic groups over the entire three-year period. The name algorithm identified 15,064 mothers with Arabic names (about 400 per month). A high percentage (82%) of Arabic-named women were foreign-born. This was similar to the percentage of self-identified Asian or Pacific Islander women who were foreign-born. The maternal characteristics of Arabic-named women were generally similar to the non-Hispanic white population.

Table 3 shows logistic regression models reflecting the birth records for the baseline period, in which low birth weight is the dependent variable. This represents the effects of race and ethnicity on low birth weight in California prior to September 2001. The unadjusted model shows that Arabic-named women have a risk of low birth weight that is similar to the risk for non-Hispanic white women (odds ratio = 1.07, a statistically nonsignificant coefficient). Maternal age, education, parity, and marital status were all significant predictors of low birth weight. However, adjusting for these factors had little effect on the odds ratios of low birth weight by racial and ethnic groups.

Table 3. Logistic Regression Models of Low Birth Weight (< 2,500 grams), by Maternal Race and Ethnicity, for Women Who Gave Birth to Singleton Infants in California, January 2000–June 2001

	Unadjusted			Adjusted		
Characteristic	Odds Ratio	*p* Value	95% Confidence Interval	Odds Ratio	*p* Value	95% Confidence Interval
Race/Ethnicity/Nativity						
Non-Hispanic white (ref.)	1.00	—	—	1.00	—	—
Non-Hispanic black	2.47	< .001	2.38–2.56	2.37	< .001	2.28–2.46
Asian and Pacific Islander	1.40	< .001	1.36–1.45	1.46	< .001	1.41–1.51
Native American	1.13	.083	0.98–1.30	1.10	.171	0.96–1.27
Hispanic	1.09	< .001	1.07–1.12	1.03	.029	1.00–1.06
Arabic named	1.07	.254	0.95–1.19	1.11	.058	1.00–1.25
Age						
< 20				1.08	< .001	1.05–1.13
20–29 (ref.)				1.00	—	—
30–34				1.15	< .001	1.12–1.18
35+				1.52	< .001	1.47–1.56
Education						
< 12				1.09	< .001	1.06–1.12
12 (ref.)				1.00	—	—
13–15				0.89	< .001	0.87–0.92
16+				0.70	< .001	0.67–0.72
Missing				1.40	< .001	1.29–1.52
First Birth				1.52	< .001	1.49–1.56
Unmarried (inferred)				1.15	< .001	1.13–1.18

Table 4 presents the relative risks of low birth weight in the post-9/11 period compared with the pre-9/11 period. For all women in aggregate, there is no difference in the risk of low birth weight in the two periods: the relative risk is 1.00. There is little difference for white, black, Hispanic, foreign-born, and Asian/Pacific Islander women. The relatively few Native American women have a modestly elevated risk that is not statistically significant ($p = .313$). However, Arabic-named women experience a significantly elevated risk: they are 34% more likely to have a low birth weight infant in the six months after September 2001 than during the pre-9/11 period ($p = .022$). The period effect is significantly different for Arabic-named women than for non-Hispanic white women ($p = .029$).

The infant's given name strongly predicts the risk of having a low birth weight infant among Arabic-named mothers in the post-9/11 period. Arabic-named women whose infants have ethnically distinctive given names have over a twofold increased risk of having low birth weight infants compared with a year earlier (relative risk = 2.25, $p = .003$), whereas those whose infants do not have an ethnically distinctive given name have a nonsignificantly elevated risk (relative risk = 1.16, $p = .318$). The percentage of Arabic-named women whose infants have ethnically distinctive given names is similar in the two periods: 23.7% in the pre-9/11 period and 21.8% in the post-9/11 period.

Table 4. Relative Risks of Low Birth Weight (< 2,500 grams) for Women Who Gave Birth to Singleton Infants During October 2001–March 2002, Compared With October 2000–March 2001

Mother's Race, Ethnicity, or Nativity	Relative Risk	*p* Value	95% Confidence Interval
All Women	1.00	.850	0.97–1.02
All Foreign-born Women	1.00	.912	0.97–1.04
Non-Hispanic White	1.00	.853	0.96–1.05
Non-Hispanic Black	1.00	.899	0.93–1.07
Asian and Pacific Islander	1.03	.331	0.97–1.10
Native American	1.19	.313	0.85–1.66
Hispanic	0.99	.592	0.95–1.03
Arabic Named	1.34	.022	1.04–1.73
Infant's given name is ethnically distinctive	2.25	.003	1.29–3.90
Infant's given name not ethnically distinctive	1.16	.318	0.87–1.54

Table 5 presents the results of the birth weight analysis that divides the observed birth weights into a normally distributed dominant distribution of term births and a residual left-tail distribution of small preterm births. The mean birth weight in the dominant distributions is lower for Arabic-named women than for non-Hispanic white women, and neither mean varies by period. For non-Hispanic white women, the percentage in the residual distribution is the same (2.2%) in both periods. However, the percentage increased from 1.8% in the pre-9/11 period to 2.8% in the post-9/11 period for Arabic-named women, a statistically significant change ($p = .022$).

For the analysis using the data on gestational age from birth certificates (for the subset of records with usable gestational ages), births that were both preterm and low birth weight were identified for Arabic-named women and non-Hispanic white women in both periods. For non-Hispanic white women, 2.7% of births in the pre-9/11 period and 2.6% in the post-9/11 period were preterm low birth weight. For Arabic-named women, 2.2% of births in the pre-9/11 period and 3.3% in the post-9/11 period were preterm low birth. The

Table 5. Birth Weight Analysis of Preterm Births, October 2000–March 2001 and October 2001–March 2002

Mother's Race/Ethnicity	Mean Birth Weight in Dominant Distribution (in grams)	*SD*	Residual Distribution (%)
Non-Hispanic White			
October 2000–March 2001	3,484	483	2.2
October 2001–March 2002	3,479	483	2.2
Arabic Named			
October 2000–March 2001	3,391	461	1.8
October 2001–March 2002	3,394	465	2.8

Notes: The analysis uses an algorithm that divides birth weights into two distributions: a dominant birth weight distribution of term births assumed to be normally distributed, for which a mean and standard deviation are reported, and a residual distribution of small preterm births (Wilcox 2001). The percentage of births in the residual distribution is reported.

relative risk of preterm low birth weight was 1.50 (95% confidence interval = 1.06–2.14) for Arabic-named women and 0.98 (95% confidence interval = 0.92–1.04) for non-Hispanic white women in the post- versus pre-9/11 period. These relative risks are significantly different from each other ($p = .025$).

DISCUSSION

Arabic-named women who gave birth in California in the six months following September 2001 experienced a moderately increased risk of low birth weight and preterm birth compared with similar women who gave birth a year earlier. Other women in California did not experience worse birth outcomes after 9/11. Moreover, the risk of low birth weight was greater among Arabic-named women whose infants had ethnically distinctive given names, which are suggestive of a stronger ethnic identification. The finding that Arabic-named women who were pregnant in September 2001 had an increased risk of poor birth outcomes is consistent with the hypothesis that ethnicity-related stress or discrimination during pregnancy increases the risk of preterm birth or low birth weight. Although this study was motivated by that hypothesis, the positive findings cannot prove causality or identify the mechanism of the effect.

What alternate types of explanations could account for the increase in poor birth outcomes for Arabic-named women? The distribution of most known risk factors for low birth weight and preterm birth would not change for an ethnic group in one year, including factors that are generally unavailable in the data, such as mother's own birth weight or lifetime experience of stress. If proximal risk factors such as maternal smoking, nutrition, alcohol use, access to care, or infection changed so rapidly for this ethnic group, it is reasonable to suspect that the underlying cause relates to the social and political environment. However, information about such risk factors is not available in these data. Another possibility is that the composition of the population changed because of security policies, including the availability and enforcement of visas. This possibility could explain these results only if women at lower risk for preterm birth differentially left the country. Although this is unascertainable, the numbers of births in the two six-month periods are almost the same among Arabic-named women (2,484 and 2,474), rendering any such differential immigration or emigration explanation unlikely. At the same time, the number of singleton births for all California women actually fell 2% from the pre- to the post-9/11 period. Another explanation would be a change in conditions that uniquely affected Arab-origin women in California but that were unrelated to 9/11, such as business failures in an industry that employed many Arab Americans. (Ramadan occurred during the study periods in both 2000 and 2001.) Such alternate explanations cannot be definitively ruled out.

There are several limitations to this study related to the method of identifying Arab-origin women by their names. Arabic-named women are likely not the same as the population of California women who would identify themselves as being of Arab descent. Misclassification would be in both directions, but should be similar in the two periods. Arab-origin women with less distinctively Arabic names may have had a different period effect on their risk of low birth weight or preterm birth. Foreign-born women are expected to be more readily identifiable using the name algorithm because of the greater likelihood that they will have distinctive given names. However, the proportion of Arabic-named women who are foreign-born is surprisingly only a little greater than would be anticipated on the basis of the 2000 census. While 82% of the Arabic-named mothers in this study are foreign-born (Table 2), 80% of California women in the 2000 census microdata sample who list an Arab first ancestry code and have a child under the age of 5 are foreign-born (Ruggles, Sobek et al. 2003). Arab American women born in the United States may not have experienced the same increased risk of poor birth outcomes, but the algorithm identified too few of them to assess their risk separately.

There are other limitations that are not related to the name algorithm. Factors that are unique to California may limit the generalizability of these findings to other states. While approximately 400 Arabic-named mothers are identified per month, low birth weight is an infrequent outcome, and the sample is too small to examine month-by-month changes in risk. The sample is also too small to examine the even less common but more clinically important outcome of very low birth weight (< 1,500 grams). Missing and inaccurate gestational ages on the birth certificates is a serious problem, limiting the ways that preterm birth may be assessed. Two different approaches are taken to circumvent the data problems and examine preterm births. These approaches focus on preterm births that are also small, which is a different outcome than that used in most clinic-based studies with valid data on gestational age. The most important limitation, though, is that it is unclear what components of the experience of being a pregnant Arabic-named woman in California in the post-9/11 period contributed to the increased risk of poor birth outcomes.

This study makes three contributions to the literature on discrimination and birth outcomes. First, presumed ethnicity-related stress that occurred during pregnancy is shown to have an effect on birth outcomes, with chronic exposures to stressors likely to be similar for women who gave birth one year apart. Second, this effect cannot be the result of unmeasured confounding by psychosocial factors that influence whether an experience is attributed to discrimination. Third, the effect is found in a previously unstudied population, women of Arab origin in the United States. Prior studies focused on African American mothers, and there may be important differences between them and Arab-origin mothers. The dimensions of their discrimination experiences may be different, including the extent to which general health and psychological status prior to pregnancy had been affected by experiences of discrimination over the life course. It is difficult to compare the magnitude of the discrimination effect in this study, which reflects an average effect across an ethnic group, to the effects estimated from studies that compare individual African American mothers to one another. Arab-origin women may have also experienced ethnicity-related stress after 9/11 that is not accurately described as discrimination (e.g., concern for relatives not in the United States).

Not every Arab-origin woman living in California would have experienced victimization personally, and one cannot identify in these data which mothers experienced discrimination. However, the entire ethnic community undoubtedly experienced a contextual effect from the widespread reports of harassment, violence, and workplace discrimination. Whatever the underlying mechanisms at work, these data show that the incidence of low birth weight and preterm births increased in the post-9/11 period for Arab-origin women and apparently not for other groups of women. Whether that increase for Arab-origin women is related to health behaviors (e.g., diet or care-seeking behavior), material circumstances, physiological effects of psychological stress, or all these factors, cannot be determined from data used in this study, but the results support the hypothesis that ethnicity-related stress during pregnancy can affect birth outcomes.

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