Health effects of Muslim racialization: Evidence from birth outcomes in California before and after September 11, 2001

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ABSTRACT

Although researchers have made progress in understanding how discrimination affects health outcomes, challenges remain in efforts to analyze the distribution of discrimination-linked stress as a population-level risk factor. Discrimination often does not align with categorical comparisons but is racialized in practice. This study explicitly tests the effects of such racialized discrimination by using the increase in anti-Muslim discrimination following the attacks of September 11, 2001 as a natural experiment. Sociological scholarship suggests anti-Muslim discrimination has been racialized in a way that affects a variety of Middle Eastern and South Asian populations who are often targeted based on physical appearance, rather than religious identification. Using a name-matching algorithm to classify mothers based on name characteristics, I examine birth outcomes for mothers with ancestry from the Middle East and North Africa, South Asia, and a subset of South Asian Sikhs. I find that rates of low birth weight births increased for both Middle Eastern and North African (1.15 RR, 95% CI: 1.00- 1.31) and South Asian Sikh (1.61 RR, 95% CI: 1.06-2.40) mothers in the 37 weeks following September 11, relative to the same period one year prior. The results highlight how processes of racialization can distribute discrimination-linked stress as a risk factor in ways that are overlooked when relying on institutionalized racial, ethnic, or religious categories to study disparities.

A growing body of research finds experiences of discrimination can have negative consequences for health and mortality. For individuals, exposure to discrimination is associated with higher risk for a range of adverse outcomes, driven in part by physiological responses to acute or chronic stress (Gee, 2002; Goosby et al., 2018; Krieger 1999, 2014; Mustillo et al., 2004; Williams, Lawrence, and Davis 2019). At a societal level, the differential distribution of discrimination experiences is put forward as a significant explanation for *patterns* of health disparities across populations or groups (Ford et al., 2019; Paradies et al., 2015; Williams et al., 2019). Despite progress in uncovering the mechanisms linking discrimination and health outcomes, challenges remain in efforts to understand the scope and distribution of discrimination as a risk factor, in part because discrimination experiences do not always align with self-defined identities or institutionalized categories. This paper contributes to such efforts by testing how racialized anti-Muslim discrimination affected the birth outcomes of both Muslim and non-Muslim populations after September 11, 2001.

The health effects of anti-Muslim discrimination are not yet fully understood, particularly in the context of increased rates of

discrimination after September 11, 2001.[1] Initial inquiries in this area have found that, as hypothesized, an uptick in anti-Muslim discrimination and violence targeting perceived Muslims immediately after the attacks of September 11 may have adversely affected the mental and physical health of Arab Americans in the United States (Abu-Ras & Abu-Bader, 2008; Padela & Heisler, 2010; Rousseau et al., 2011; Samari, 2016; Samari et al., 2018). For instance, Lauderdale (2006) used September 11 as a natural experiment to observe how discrimination-linked stress likely increased low birth weight births among Arabic-named mothers in California in the wave of anti-Arab and anti-Muslim hate crimes that followed the attacks. It remains unclear whether similar discrimination-linked social stressors affected the health of other populations, such as non-Muslim Middle Eastern and South Asian populations. The primary mechanism involved—stress in response to an increase in anti-Muslim discrimination—not only affected self-identified Muslims, but was also experienced by groups who are frequently misidentified as Muslim based on racialized physical characteristics, most notably South Asian Hindus and Sikhs (Ahluwalia and Pellettiere 2010). One of the first fatalities in the wave of post-9/11

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hate crimes was Balbir Singh Sodhi, a Sikh gas station attendant who immigrated to the United States from India (Lewin, 2001).

Although acts of discrimination targeting Muslim and Middle Eastern and North African (MENA) populations after September 11 are often labeled as Islamophobic or anti-Muslim, religion was not a prerequisite for experiencing the backlash. Rather, physical appearance often served, and continues to serve, as a marker for social exclusion and discrimination (Love, 2017). This may include cultural practices that are perceived as Islamic—such as wearing head coverings and other forms of distinctive dress—or the ascribed categorization of physical traits, including skin color (Garner & Selod, 2015). Although neither Muslims nor MENA populations are distinguished using popular or legal definitions of race—individuals from the Middle East and North Africa are formally considered white (OMB, 1997)—race theory and scholarship have become increasingly important for understanding their social experiences (Selod & Embrick, 2013). Racialization—or the extension of racial meaning to a previously racially unclassified social practice or social group (Omi and Winant 1994)—is essential for understanding how religious identity is framed in racial terms and how ostensibly religious-based discrimination affects individuals who are not Muslim (Galonnier, 2015; Garner & Selod, 2015; Guhin, 2018; Kibria, 2011; Read, 2008; Selod 2014, 2019; Zopf, 2018). Racialized anti-Muslim discrimination draws boundaries around groups in ways that do not match their formal classifications or self identities, and subjects individuals with varied racial, ethnic, and religious backgrounds to similar social experiences based on the shared characteristic of "looking Muslim."

The goal of this paper to explicitly operationalize Muslim racialization and test its effects on birth outcomes. The design builds on previous research that treated September 11 as a natural experiment to observe an increase in low birth weight births for Arabic-name women in the period immediately after the September 11 attacks (Lauderdale, 2006). Using birth record data from California, I identify additional subgroups of mothers using name-matching methods. The population of focus is not limited to U.S. Muslims or MENA immigrants, but the broader range of individuals with a shared social experience shaped by post-9/11 anti-Muslim racialized discrimination. This includes mothers with ancestry from Arab and non-Arab countries of the Middle East and North Africa, non-Muslim majority South Asian countries, and a subset of South Asian Sikh mothers. The literature on Muslim racialization suggests these additional groups shared similar risk for stress-induced adverse birth outcomes in ways that may not be captured with categorical representations of race, ethnicity, or religion.

Background

Racialized discrimination and the distribution of risk factors

Discrimination has received a growing amount of attention from researchers interested in explaining health disparities. Experiences of interpersonal discrimination can be a source of acute or chronic stress capable of triggering a number of physiological responses and hormonal changes linked with elevated disease risk (Gee, 2002; Krieger 1999, 2014; Mustillo et al., 2004). The disproportionate burden of stress in an environment of systemic racism has become an important explanation for a variety of outcome disparities between black and white populations in the United States, and it helps account for residual differences that remain after accounting for socioeconomic status (Williams et al., 2019). Even among minority groups with relatively good overall health profiles, such as Hispanic and Asian immigrants, studies have found an association between discrimination and poor health outcomes that may not be apparent in average population health comparisons (Finch et al., 2001; Finch et al., 2004; Gee et al., 2007; Yoo et al., 2009).

As with any cause or risk factor, population health researchers are not only interested in how and why discrimination affects health, but also who is likely to be affected. Yet studying the distribution of

discrimination-induced stress as a risk factor is complicated by a disconnect between discrimination experiences and the institutionalized social categories that often form the basis for population health comparisons. Discrimination in practice may differ from public discourse and often intersects with multiple identities in the context of the U.S. racial hierarchy. For example, anti-immigrant discrimination and even more narrowly-focused discourse about "illegality" often target U.S.-born Hispanics (García 2017). Similarly, discrimination motivated by religious intolerance often extends to non-practicing or non-religious members of similar ethnic or national populations, such as with Jewish and Catholic migrants to the United States in the early 1900s or Muslim migrants in recent decades (Brodkin, 1998; Garner & Selod, 2015; Ignatiev, 2009).

Research design that treats discrimination as an exogenous exposure differentially experienced by existing groups may miss important at-risk populations. One solution to this dilemma is to incorporate research on racialization into research design and population comparisons. Racialization is an important theoretical concept for understanding how discrimination is experienced within and between groups. Defined by Omi and Winant (1994) as "the extension of racial meaning to a previously racially unclassified social practice or social group," racialization shifts focus from fixed categories of race to the dynamic "processes by which ideas about race are constructed, come to be regarded as meaningful, and are acted upon" (Murji & Solomos, 2005, p. 1). This often operates via ascribed categorization of physical or cultural traits assigned to groups in ways that can be incongruous with formal racial classifications. Religious and ethnic minorities in the United States—at various times including Jews, Muslims, Irish Catholics, and other immigrants populations—have experienced discrimination that attaches racial meaning to their perceived identity and excludes them from whiteness as a social category (Galonnier, 2015; Samari et al., 2019). Racialization as a social process "draws a line around all members of a group" in ways that may not match other forms of classification (Garner & Selod, 2015). Incorporating scholarship on racialized discrimination directly into research design may help researchers better identify the heterogenous populations at risk for discrimination-linked stress.

Muslim racialization before and after September 11

Although Muslim and MENA populations are targets of discrimination in the United States, these groups have been understudied in research on discrimination and health, as well as health disparities scholarship more broadly. This is in part because the U.S. Census and other official data sources do not collect information about religion. However, immigrants from Muslim-majority countries of the Middle East and North Africa are challenging to include in research focused on racial disparities due to the reliance on formal and institutionalized racial categories for comparing between-group outcome differences.

Throughout U.S. history, the formal racial classifications of Arab and non-Arab populations from Muslim-majority countries have varied, as have their social experiences of the U.S. racial hierarchy. Like other groups, their racial identities, and specifically their claims to whiteness, were contested and institutionalized in the legal system (Lopez, 1997; Maghbouleh, 2017). By 1978, the Office of Management and Budget formally defined the white category on the U.S. Census to include individuals with ancestry from the Middle East or North Africa. Despite formal classification as white, the social experiences of these groups have not always matched their legal standing (Maghbouleh, 2019; Naber, 2000). In art, scholarship, and the media, Muslims and Arabs have long been portrayed as villainous and uncivilized, and "orientalized" as a cultural contrast to the West (Said, 1978; Shaheen, 2003). Interactional discourse often racializes these groups as "brown" or non-white (Zopf, 2018). As a result, many groups from the Middle East and North Africa are rendered simultaneously "invisible" in the ethno-racial hierarchy via top-down racial formation processes formalized in legal recognition and institutional categorization, and at the

same time "hypervisable" via bottom-up racialization experiences that place them at the limits of whiteness as a social category (Maghbouleh, 2017).

Discrimination is central to this racialization process. Discrimination targeting Muslims is often analyzed under the umbrella of Islamophobia, a term indicating a fear or hostility directed toward Islam as a religion. However, religion is not a prerequisite to experiencing the effects of Islamophobia, nor its health consequences (Abdulrahim et al., 2012). Rather, physical appearance often serves as a marker for exclusion and discrimination. This may include cultural practices that distinguish Muslims, such as head scarfs and other forms of distinctive dress (Selod & Embrick, 2013). But physical markers—brown skin and long beards among men—can also be the basis for exclusion. Importantly, this racialized targeting of physical traits subjects non-Muslims and non-MENA populations to anti-Muslim discrimination. Among the most common non-Muslim targets are South Asian Sikhs, who are neither Muslim nor Arab, yet their long beards and distinguishing turbans led to similar experiences of discrimination and violence after the attacks of September 11 (Ahluwalia and Pellettiere 2010).

Scholars have increasingly argued in favor of understanding Islamophobia—and the broader social experiences of both Muslim and non-Muslim groups from the Middle East, North Africa, and South Asia—as racialized, both conceptually and in practice (Cainkar, 2009; Garner & Selod, 2015; Guhin, 2018; Love, 2017; Selod 2014, 2019; Selod & Embrick, 2013; Zopf, 2018). This not only adds a racial layer to a social group that identifies through shared religious identification, but it also extends the effects of Islamophobia to any similarly categorized groups, creating "a racialized master category governs and links Arabs, Middle Eastern, Muslim, and South Asian Americans, despite the seeming incompatibility of their ethno-racial labels and internal diversity" (Maghbouleh, 2017, p. 170). If anti-Muslim discrimination has consequences for health, it is likely to affect these non-Muslim populations as well.

Birth outcomes and September 11 as a natural experiment

Discrimination against Muslims and MENA populations existed well before 2001. Yet the attacks of September 11, 2001 marked a turning point for the experiences of Muslim and MENA immigrants and their descendants in the United States. The FBI documented a 1600 percent spike in hate crimes in the period immediately after September 11 (Disha et al., 2011). The U.S. Economic Employment Opportunity Commission reported an increase in workplace discrimination charges filed by Muslims and individuals of Middle Eastern ancestry (EEOC, 2019). Symbolic and social boundaries hardened in other ways, often manifesting in harassment, surveillance, and social exclusion (Bail, 2014; Cainkar, 2009; Love, 2017; Selod, 2014).

Research has increasingly documented how such experiences of discrimination can increase stress responses and have negative effects on health outcomes. A portion of this work has relied on low birth weights as an indicator of maternal and child health (Alhusen et al., 2016; Dominguez et al., 2008). This is a useful indicator, in part, because it is sensitive to short- and long-term exposure to stress. The stress response in the mother can trigger the production of placental corticotrophin-releasing hormone (CRH), which can induce preterm birth and is associated with reduced birth weight (Lockwood, 1999). The hormonal response can be triggered by short-term shocks, such as earthquakes or wars, that act as acute stressors during pregnancy (Torche 2011, 2019; Torche & Shwed, 2015). But it also is associated with long-term chronic stress experienced before pregnancy, including prolonged exposure to racial discrimination (Alhusen et al., 2016; Dominguez et al., 2008).

Because birth weight outcomes are determined within a relatively short window and sensitive to disruptive events, natural experiments can be methodologically useful for establishing a link between discrimination, acute stress experiences, and birth weight (Torche, 2011). In cases where an exogenous exposure symbolically targets an ethnic or racial minority group, effects can be observed among members of the group who do not directly experience it directly. For instance, events such as a major immigration raid or anti-immigrant political developments have been shown to increase stress and affect rates of adverse birth outcomes for both foreign-born and U.S.-born Latina mothers, suggesting discrimination-linked stress can affect broader communities via social ties and psychosocial mechanisms (Gemmill et al., 2019; Novak et al., 2017; Torche, 2019).

The post-9/11 wave of anti-Muslim discrimination arguably represented a similar symbolic threat to individuals who did not necessarily experience it directly. Previous studies suggest this increase in discrimination was detrimental to the mental and physical health of such groups in the short term (Padela & Heisler, 2010). In a study using California birth outcome data, Lauderdale (2006) treated September 11 as a natural experiment for analyzing the causal effect of the increase in discrimination against Arab mothers. Using a name-matching technique to identify Arabic-named mothers among birth certificate data, she found a spike in low birth weight births for Arab mothers after September 11, which was not seen for other ethno-racial groups, although a similar study of Arab Americans in Michigan found the opposite effect (El-Sayed et al., 2008). This paper relies on the same dataset to address unanswered questions about the scope and distribution of the effect in California. Specifically, did discrimination-linked stressors similarly affect the birth outcomes of groups commonly misidentified as Muslim or Arab, such as South Asian Hindus and Sikhs? Although researchers have increasingly documented the dynamics of post-2001 Muslim racialization (Kibria, 2011; Selod, 2014; Selod & Embrick, 2013), we still do not fully understand its consequences, particularly for health outcomes (Samari, 2016; Samari et al., 2018).

Methods

Data

This study tests the health effects of Muslim racialization by examining birth outcomes in California before and after September 11, 2001. The data come from California Vital Statistics Records. California has sizable populations with ancestry from the Middle East and North Africa and South Asia, and its distance from the attacks of September 11 reduce the confounding influence of stress associated with the event itself. Access to records for all births in California during the study period was granted by the California Department of Public Health. The data not only contain medical information about each birth in the state, but they also include given name and surname data for the mother, father, and infant associated with each birth record. Due to the sensitive nature of the records, a data security protection plan was developed and the protocol was approved by the Committee for the Protection of Human Subjects of the California Health and Human Services Agency and the California State Registrar.

Following other studies that have treated events as natural experiments to examine birth outcome patterns, this study divides the records into two comparable periods. Individuals were classified in the "treatment period" if births occurred in the 37 weeks after September 11, 2001. Births were classified in the "pre-treatment" period if born in the same 37-week window one year earlier. Thirty-seven weeks is the minimum length of a term gestation, and this baseline comparison period captures effects among women who were pregnant on September

11. Births are compared with the same period one year prior to avoid confounding influences related to cyclicality and seasonality in birth outcomes.[2] However, because the exposure of interest is not the events of September 11 but the wave of violence and discrimination that followed, additional exposure windows are tested, extending from six months until one year after the attacks. Data on hate crimes and employment discrimination lawsuits suggest a rapid increase in incidents immediately after September 2001, with the vast majority of reported anti-Muslim or anti-Arab hate crimes in California occurring in September and October of 2001 (Federal Bureau Of Investigation, 2018). Although various measures of anti-Muslim discrimination never declined to their pre-2001 lows, the precipitous relative decrease in hate crimes after October 2001 suggests the weeks immediately following September 11 represented a period of particularly elevated discrimination and a possible source of acute stress experiences. The final dataset includes the entire population of 1,059,275 births occurring in California during the year before and year after September 11, 2001.

Measures

Birth outcomes

The primary dependent variable is an indicator of low birth weight. Each birth record contains the infant weight at birth in grams. Following national standards, infants weighing less than 2500 g were classified as low birth weight (LBW). Although many studies of birth outcomes also examine preterm birth as an indicator, the gestational age data in the California records during this period are unreliable and return unrealistic distributions of weight for gestational age categories.

Name-matched ancestry

Testing the racialization hypothesis requires identifying populations who likely experienced discrimination in the post-9/11 period. The key independent variable was an indicator of group ancestry that combines indicators of race, ethnicity, and name-matched ethno-national identity. Although religious identification data were not available for distinguishing Muslim and non-Muslim mothers, this study innovates by using parental name data to probablistically identify individuals with likely ancestry from Muslim-majority and non-Muslim Majority countries of the Middle East and North Africa and South Asia. These groups are typically classified as White or Asian in institutionalized race categories and are therefore often overlooked in population health records. Individuals with names originating from the 22 countries of the Arab league or non-Arab majority countries of Iran, Afghanistan, and Pakistan were classified as MENA.[3] Individuals with names originating in India and Nepal were classified as South Asian.

In addition to the broader South Asian category, a separate category was created for individuals classified as Sikh, who often adopt identifiable surnames to indicate religiosity and gender. Sikh men commonly adopt the surname "Singh", and women adopt the surname "Kaur." This distinctive naming approach allows for more precise classification criteria than the broader South Asian group. Although the racialization hypothesis would predict discrimination effects for the general

population of non-Muslim South Asian mothers, there are reasons to expect a unique effect among the Sikh population, as they are frequently mis-identified as Muslim because of ethno-religious traditions, such as wearing turbans and maintaining long facial hair. Only the mother's surname was used for the primary analysis, but the Appendix includes alternative specifications that include the father's surname. Comparison groups included non-Hispanic white, non-Hispanic black, Asian and Pacific Islander, Hispanic, and an other category.

Name-matching techniques have been used to identify populations for which data are not readily available, particularly for epidemiological purposes (El-Sayed et al., 2008; Nasseri et al., 2007). Surnames common to a given ethnicity or nationality can be used to probablistically classify individuals based on name uniqueness, and patterns of first names can similarly serve as an indicator of ethnic identification or assimilation (Gerhards & Hans, 2009; Goldstein & Stecklov, 2016; Lieberson & Carter, 1979). The technique typically relies on an external source list of names with corresponding national origin or ethnicity information, which is then matched to available name data in health records. This study relies on a list of names provided by the Social Security Administration that includes country of origin information for foreign-born individuals who submitted a social security application. For each given name and surname, its occurrences among MENA and South Asian immigrants are calculated relative to the total number of occurrences, giving an indicator of ethno-national uniqueness and a way to probablistically classify name combinations. Names were included if they had at least five occurrences associated with at least one of the MENA or South Asian groups, as defined by the countries listed above. The proportional representation of each name was calculated, and the resulting source file included 44,225 given names and 50,096 surnames.

The first step in classifying names involved matching the mother's given name and maiden name in the birth records. Following similar studies, a positive match was identified if the combination of scores for the given name and maiden name was higher than .20 (Lauderdale, 2006). Identifying individuals via name-matching runs the risk of both Type I and Type II errors. Because some of the more common names in MENA countries are Muslim names, some Muslims who are not from the Middle East may be mistakenly classified as MENA. False negatives may be a more significant problem, as classification depends on the completeness of the external matching list. As shown in Appendix A1, only 33.9% of records had a match on both given name and surname SSA lists. For these records, a score could be easily calculated. However, more than half of the birth records matched only the first or last name. Because the external list is not exhaustive in terms of common names or spelling variants, a particular problem for names transliterated to En-

Table 1

Previous ethno-racial classification of mothers with MENA and south asian names.

Original classification	MENA		South Asian	
	n	%	n	%
Asian and Pacific Islander	3789	26.6	13,650	86.8
Non-Hispanic Black	1105	7.8	237	1.5
Hispanic	967	6.8	475	3.0
Other	69	0.5	93	0.6
Non-Hispanic White	8108	57.0	1075	6.8
Not Specified	189	1.3	201	1.3

Based on birth records in the expanded comparison period spanning September 12, 2000 to September 10, 2002.

glish from another language, it is possible that the lack of a match represents a false negative. In order to calculate a score for these cases, I impute the missing name score using a combination of the father's given

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[2] Birth outcomes—including conception patterns, gestation length, and birth weight—exhibit patterned seasonal fluctuations that can confound comparisons across time if not controlled for (Currie & Schwandt, 2013; Darrow et al., 2009). A portion of such seasonal variation may be driven by selection processes related to socioeconomic and ethno-racial variation in conception patterns that may affect birth outcomes (Darrow et al., 2009). However, even when controlling for selection, evidence suggests season of conception is related to gestation, as birth weight can be 8–9 g more among births conceived in summer months (Currie & Schwandt, 2013).

[3] Although Pakistan is geographically typically considered part of South Asia, it was included in conceptualizations of the "Greater Middle East" that shaped U.S. foreign policy after September 11, 2001 (Güney & Gökcan, 2010).

name and surname and the child's given name.[4] In cases where this information is available, these account for 65% of the variation in the mother's name score. For South Asian mothers, an Asian Indian racial category in the birth records was also used.

Table 1 shows the breakdown of how mothers classified as having MENA or South Asian names were previously identified in the ethnicity and race categories available in the birth records. For South Asian mothers, the vast majority were previously classified as Asian, as expected. There was more ambiguity in the results for mothers identified as MENA via the name-matching method. The majority, 57%, were previously classified as non-Hispanic white, matching their typical Census classification. However, an additional 26.6% were previously classified in the Asian and Pacific Islander category. This may be in part because of the inclusion of Pakistan in the definition of MENA. It may also reflect the ambiguity in how MENA Americans understand their racial classification in the United States. Because the name-matching approach matches names common to the Muslim-majority countries being analyzed, it is also possible that Muslim names from East Asian countries are being classified as MENA. The records for these years do not contain country of birth information for teasing out some of these explanations.

Control variables

The California Vital Statistics records include information about the biological and social characteristics of the family. Birth characteristic controls included the age of the mother (categorized as less than 20, 21–25, 26–30, 31–35, 36–40, more than 40 years old), the sex of the child, the birth order for multiple births, the number of previous births (1 = first birth, 0 = other), and a control for pregnancies at term by September. In addition, available social characteristics were controlled for, including the mother's level of education (distinguishing between less than high school, high school degree, some college, and college degree), whether the mother was foreign-born, and the month in the pregnancy in which the mother began prenatal care.

Analysis

The analysis operationalizes the attacks of September 11 as an exogenous source of variation in experiences of racialized discrimination for groups from the Middle East and North Africa and South Asia. The first step relies on the calculation of risk ratios measuring the incidence of low birth weight birth in the post-9/11 "exposure" period relative to the prior year. As noted previously, the rapid increase in reported hate crimes and other forms of discrimination is well documented, yet the exposure window extended for months after the initial attacks. Therefore, subsequent analyses expand the measurement window and include control variables, using the following general regression equation to model the average effect:

$$Pr(LowBirthWeight = 1) = \beta_0 + T_i\beta_1 {}^*G_i\beta_2 + X_i\beta_x + \varepsilon_i$$

The group and time period interaction facilitates testing for a general September 11 effect, as well as treatment effects for the MENA, Sikh, and South Asian exposure groups relative to other ethno-racial populations. I use linear probability models with robust standard errors to account for heteroskedasticity.

Unlike many natural experiments in which an event can be treated as a one-time exposure, the post-9/11 backlash continued for multiple months. Because the results may be sensitive to specification of the pre- and post-event periods, in subsequent analyses I run multiple models with varying specifications of *T*, ranging from six-month to twelve-

[4] Alternative methods were tested using fuzzy matching and machine learning algorithms to detect spelling variants of common Middle Eastern and South Asian names. However, these methods produced more apparent mismatches than imputing from family members.

month comparison periods. In the initial comparison window, most women in the treatment period were already pregnant on September 11, so composition or behavioral differences across the periods are unlikely. However, as pregnancies conceived after September 11 are included, it is possible that changes in fertility decisions, care utilization, or other factors may affect the composition of births in the two periods. The final set of models includes controls for the birth and sociodemographic characteristics discussed previously.

Results

Because the data represent the full population of births in California, descriptive comparisons of outcome rates provide an initial answer to the question of possible stress effects on birth outcomes for each group. The unadjusted rates of low birth weight births and other birth characteristics for each group are presented in Table 2. Rates of low birth weight births for mothers identified as MENA increased to 8% in the 37 weeks following September 11, 2001, from 6.97% in the same 37-week period one year prior. The Sikh subsample saw a larger increase in rates of LBW births, from 6.06% in the pre-9/11 period to 9.73% after. However, the broader non-Sikh South Asian population did not exhibit a similar increase as expected under the racialization hypothesis, and in

Table 2
Descriptive statistics for births before and after September 11, 2001.

	Birth weight (grams)	Low birth weight (%)	Percent female	Percent first birth	Number of births
Non-Hispanic White					
Pre 9/11	3415.5	5.9	48.7	41.9	116,413
Post 9/11	3412.9	5.9	48.6	42.0	113,338
MENA					
Pre 9/11	3293.3	7.0	46.8	40.7	4951
Post 9/11	3272.6	8.0	47.4	39.9	5085
Sikh					
Pre 9/11	3276.9	6.1	46.6	40.8	545
Post 9/11	3209.5	9.7	44.0	44.3	586
South Asian					
Pre 9/11	3170.0	9.0	49.3	54.4	5453
Post 9/11	3176.1	8.7	47.8	55.4	5679
Asian					
Pre 9/11	3240.1	6.7	48.2	45.6	38,909
Post 9/11	3238.0	7.1	48.5	45.5	37,358
Non-Hispanic Black					
Pre 9/11	3165.8	11.7	50.2	36.5	22,911
Post 9/11	3162.8	11.6	49.6	36.3	21,868
Hispanic					
Pre 9/11	3365.6	5.6	49.0	34.9	183,790
Post 9/11	3361.9	5.6	49.4	34.5	184,095

The table compares birth statistics for the 37 weeks after September 11, 2001 (labeled 'Post 9/11′) with the same 37-week period one year prior ('Pre 9/11′).

fact rates of low birth weight births declined slightly from 9.0% to 8.7%. For comparison, the rates of low birth weight births were unchanged across the two periods for non-Hispanic White, non-Hispanic Black, and Hispanic mothers. The rate for Asian mothers increased by less than 0.4 percentage points. Because data are selected from similar months before and after September 11, it is unlikely that differences after the attacks are due to seasonal trends.

Fig. 1 plots the monthly rate of low birth weight births for each group in the two years before September 11, as well as the trends for non-Hispanic whites, to rule out longitudinal trends occurring before the event that might have uniquely affected the treatment groups. Although monthly data for such small populations are highly variable and not suitable for systematic time-series analysis, they are sufficient for examining smoothed trends. There is no evidence of year-over-year increases leading up to September 11 for the comparison groups. In addition, the increase in low birth weight births appears isolated to Middle Eastern and South Asian populations, relative to the rate for the non-Hispanic white population. Because the attacks of September 11 were themselves a possible source of acute stress, the lack of a general effect is noteworthy, as it isolates the post-event rise in discrimination as a likely mechanism. If the events of September 11 were the primary stressor, the change in birth weights would have likely occurred across multiple groups. Although previous research found a possible population-level effect of September 11 on the male-female sex ratio at birth, the effect was short-lived and the studies did not disaggregate by ethnicity, race, or religion (Catalano et al, 2005, 2006).

The primary treatment effect on birth outcomes across the two periods can be analyzed as an increase in relative risk. Fig. 2 plots risk ratios and 95% confidence intervals of the post-9/11 change in risk of low birth weight births for each group in the baseline comparison period of 37 weeks after September 11, 2001, compared to the same 37-week period one year prior. Both MENA (1.15 RR, 95% CI: 1-1.32) and Sikh (1.61 RR, 95% CI: 1.06–2.43) mothers had substantial and statistically significant increases in relative risk of low birth weight birth across the two periods. This is the comparison period in which inferences about stress effects are most straightforward because nearly all of the women were already pregnant on September 11, 2001, making fertility decisions and behaviors less relevant. For the broader category of South Asian mothers, the risk ratio between the two periods is not significantly different from 1 (0.97 RR, 95% CI: 0.86–1.09).[5]

The final step of the analysis incorporates control variables across three comparison windows (Table 3). For both Sikh and MENA mothers, effect sizes differ across comparison windows. In the shortest measurement period, six months after September 11 relative to the same period one year prior, the probability of low birth weight birth for MENA mothers increased from 5.9% to 7.4% (p < 0.05), controlling for a number of birth characteristics and sociodemographic factors. Although controlling for these characteristics reduces the baseline probability of low birth weight birth, the treatment effect is still statistically significant in the model. The effect size for the Sikh subsample was similar during

the six-month window—increasing from a probability of 5.7%–7.5%—but the change was not statistically significant.

For MENA mothers, the effect size in the nine-month and twelve-month comparison windows declined relative to the six-month window and was not significantly different from zero. Expanding the number of weeks in the measurement window increases the number of births but also increases the likelihood of confounding factors influencing birth outcome patterns. For Sikh mothers, the effect was largest (and statistically significant at the p < 0.05 level) in the nine to twelve months after. In the nine-month comparison window, the probability of low birth weight birth among Sikh mothers increased from 5.5% to 9.0%.

Discussion

Previous research found an increase in adverse birth outcomes for Arabic-named mothers in the period immediately after September 11, 2001 in California, likely due to an increase in exposure to anti-Muslim and anti-Arab discrimination (Lauderdale, 2006). This paper set out to test whether racialized anti-Muslim discrimination resulted in similar changes in low birth weight births for non-Arab and non-Muslim mothers across a similar period. The findings suggest a similar negative effect on birth outcomes for Sikh mothers, who had a nearly 60% higher risk of low birth weight birth in the 37 weeks following September 11 relative to the period one year prior. This aligns with initial expectations of the racialization hypothesis. Scholars have long argued that Muslim racialization affects both Muslims and non-Muslims (Garner & Selod, 2015; Guhin, 2018; Kibria, 2011; Read, 2008; Selod 2014, 2019; Zopf, 2018). This study provides evidence of its consequences for birth outcomes.

Given the lack of change for other ethno-racial groups and the exogenous shock of September 11 and the backlash that followed, these findings suggest the rapid increase in anti-Muslim discrimination created experiences of acute stress as a risk factor for low birth weight.[6] This study extends previous findings by demonstrating how racialization distributed this risk across both Muslim and non-Muslim populations. It is unlikely that the increase in low birth weight births was limited to women who were direct victims of hate crimes. Rather, the rise in violence and discrimination, and its visibility, created a more hostile and threatening social environment that elevated stress levels among a range of individuals who feared for their future safety and wellbeing. Neither Muslim identification nor Arab ethnicity were prerequisites for being targeted by the wave of discrimination that followed the September 11 attacks, and non-Muslim South Asian populations were among the victims.

The results did not support the racialization hypothesis for non-Sikh South Asian mothers. There are a number of possible explanations for this worth exploring in future research. One possibility is a delayed or null effect related to psychosocial interpretations of discrimination or group identity (Schnittker & McLeod, 2005). Non-Muslim South Asian residents of California may not have perceived themselves as initial targets of ostensible anti-Arab or anti-Muslim sentiment, even if among the victims. There are also demographic differences between the two groups. More than 40% of California's MENA population lived in the Los Angeles metropolitan area, according to the 2000 Census, whereas the South Asian population was more dispersed throughout the state. This may have increased the likelihood of experiencing discrimination directly or knowing someone who experienced discrimination for spatially-concentrated MENA communities.

It is also possible that hate crimes and other acts of discrimination targeted cultural or ethnic markers, such as turbans and long facial hair,

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[5] As a robustness check for the name-matching technique, Figure A3 in the Appendix presents the results of an alternative method of identifying mothers and relative risk. Because the categorization of mothers relies on a probabilistic name-matching methods, the results may be sensitive to the name-matching threshold. Because each name includes a number that corresponds to how unique it is to a given national or regional origin, the effect of each mother's likelihood of belonging to a group can be tested using a continuous measure, rather than discrete groups. The effect size, measured as the coefficient for the post-9/11 "treatment" period in a linear probability model, was larger for women with more ethnically-distinct MENA names when using varying thresholds for inclusion. The effect size increases substantially among mothers whose names are almost exclusive to the Middle East and North Africa, suggesting the baseline model may underestimate the effect. The same association between ethnic name score and effect size was not seen for the general South Asian comparison group.

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[6] Although previous research suggests acute stress responses may have larger effects during the first trimester of gestation by reducing gestational age (Torche 2011), this study was not able to pinpoint the timing of exposure.
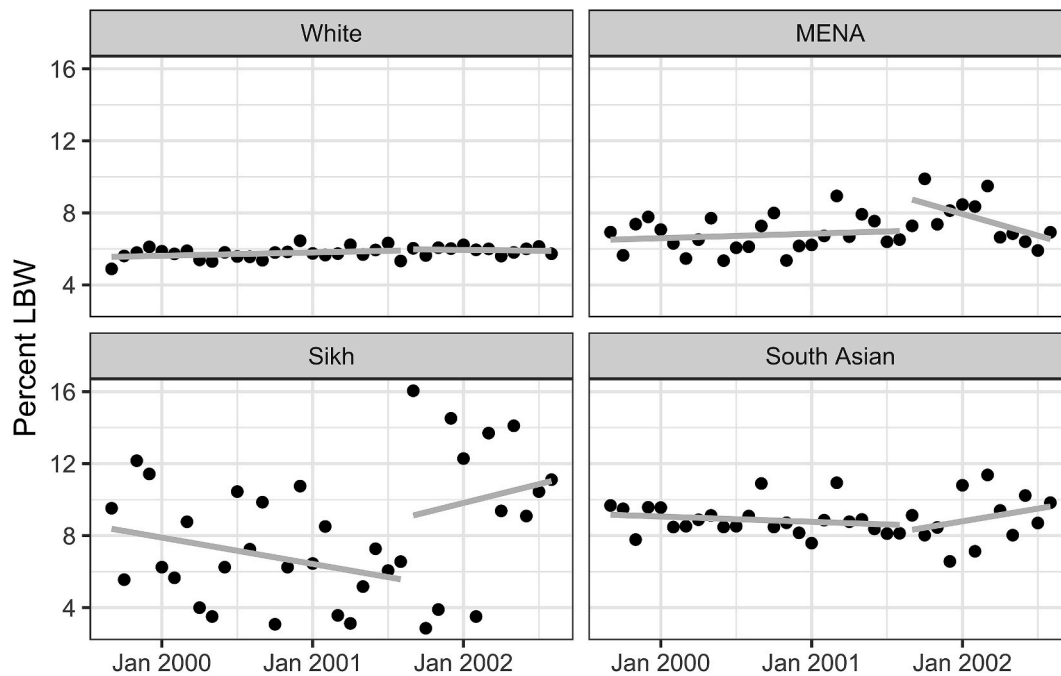
Fig. 1. Rates of low birth weight births from September 1999 to September 2002.
Dots represent monthly rates of LBW births. Lines represent linear trends before and after September 11, 2001.
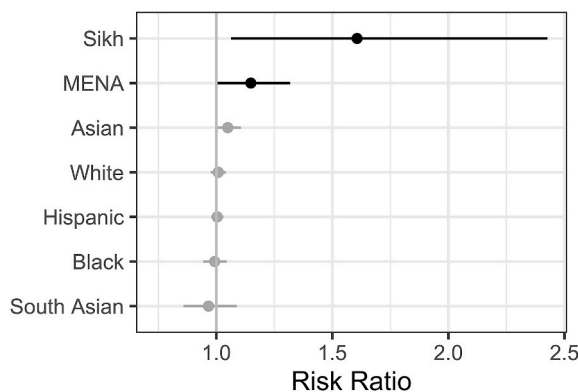

Fig. 2. Risk ratio of low birth weight birth after September 11, 2001.
Risk ratio of low birth weight birth and 95% confidence intervals, calculated based on incidence in the 37 weeks after September 11, 2001 relative to the same period one-year prior.

Table 3
Analysis of post-9/11 effect on low birth weight births.

	Six Month	Nine Month	Twelve Month
Intercept	0.039 ***	0.040 ***	0.040 ***
	(0.002)	(0.001)	(0.001)
Post-9/11	0.001	−0.000	0.000
	(0.001)	(0.001)	(0.001)
Group (ref. Non-Hispanic White)			
MENA	0.020 ***	0.021 ***	0.021 ***
	(0.004)	(0.004)	(0.003)
Sikh	0.018	0.015	0.018 *
	(0.012)	(0.010)	(0.009)
South Asian	0.045 ***	0.044 ***	0.043 ***
	(0.005)	(0.004)	(0.003)
Asian	0.020 ***	0.019 ***	0.020 ***
	(0.002)	(0.002)	(0.001)
Black	0.059 ***	0.059 ***	0.060 ***
	(0.003)	(0.002)	(0.002)
Hispanic	0.007 ***	0.007 ***	0.007 ***
	(0.001)	(0.001)	(0.001)
Interaction			
MENA x Post-9/11	0.014 *	0.010	0.006
	(0.006)	(0.005)	(0.004)
Sikh x Post-911	0.017	0.035 *	0.030 *
	(0.018)	(0.015)	(0.013)
South Asian x Post-9/11	−0.008	−0.003	−0.001
	(0.006)	(0.005)	(0.004)
Asian x Post-9/11	0.002	0.002	0.003
	(0.002)	(0.002)	(0.002)
Black x Post-9/11	−0.001	−0.001	−0.002
	(0.004)	(0.003)	(0.003)
Hispanic x Post-9/11	−0.002	0.000	0.000
	(0.001)	(0.001)	(0.001)
N	514,460	729,847	1,034,669

***p < 0.001; **p < 0.01; *p < 0.05. Results based on linear probability models with robust standard errors. Models include controls for the sex of the child, previous births, birth order (for multiple births), pregnancy at term in September 2001, and the mother's age, education, and nativity status.

that distinguish Sikhs from other South Asian groups. Research has found Muslim women who wear a head coverings report more discrimination (Martin, 2015), and turbans shape discrimination experiences for Sikh men (Nadimpalli et al., 2016). Although some scholars rely on the term "ethnicization" when sociocultural markers are the primary basis of differentiation (Ford & Harawa, 2010), it is important to note that racialization often involves a combination of cultural and phenotypical distinctions, particularly when applied to Muslims and other racialized religious minority populations (Selod & Embrick, 2013). For instance, the importance of both material and phenotypical markers can be seen in the ambiguous racialization experiences of white converts to Islam (Galonnier, 2015). Future research would benefit from identifying additional groups, such as Christian Arabs or European Muslims, to disentangle these overlapping influences.

There are limitations to this study, and to research on MENA and Muslim populations in general. The robustness of the results hinges on the use of naming patterns to classify the ethnic background of mothers in the birth records. As shown in Appendix A3, the effect size for

increased risk of low birth weight birth varies according to the threshold used for classifying mothers. Although this provides evidence that reinforces key findings—the effect size was larger when limited to

uniquely MENA names—it also raises the possibility of Type I or II errors that depend on the name classification threshold. Regardless of classification methods, names can be imperfect identifiers. This method may have missed Muslim or MENA women with less distinctive names, and it may have failed to distinguish between regional/ethnic and religious naming conventions. Many of the matched names are common to Muslim populations around the world, including the United States.

Despite the limitations of the study, the findings for Sikh mothers have both empirical and theoretical implications. The results provide evidence that the effects of anti-Muslim and anti-Arab discrimination were not limited to self-identifying Muslims and ethnic Arabs. In order to understand the scope and magnitude of the health effects of such discrimination experiences, it is valuable to look beyond racial, ethnic, and religious self-identification or categorization. Groups frequently racialized as Muslim—including non-Muslims from the Middle East and South Asia—were also affected by the changing social conditions. Previous research has found similar discrimination-linked health effects among Arab Christians (Abdulrahim et al., 2012), but the results of this study suggest it is important to consider its effects among other non-MENA populations, as well.

The distribution of outcomes in the immediate post-9/11 period can inform future research on the health effects of anti-Muslim discrimination in the decades that followed. Although hate crimes and indicators of discrimination declined within a few months after September 11, they never fell to their pre-2001 lows, suggesting an ongoing environment of stress that may have continued to affect birth outcomes in ways not measured in this study, including via miscarriage rates, health care utilization patterns, or conception decisions. Whereas this study focused on acute stress experiences tied primarily to interpersonal discrimination experienced during pregnancy, anti-Muslim discrimination may have continued to affect outcomes via chronic stress experienced before pregnancy. As the initial post-9/11 backlash subsided, anti-Muslim discrimination was institutionalized by organized political and civil society organizations in the years that followed (Bail 2012, 2014). Although future research on the longer-term trends in birth outcomes and health disparities may require different avenues for measuring discrimination experiences and an incorporation of chronic stress as a mechanism, this study suggests that work would benefit from examining how racialization may have affected non-Muslim and non-MENA populations.

The theoretical implications of this research extend beyond studies of Muslim racialization to general research and theory on discrimination, identity, and health disparities. Race theorists have long used the concept of racialization to understand how racial categories and identities are formed via historical and social processes (Murji & Solomos, 2005; Omi and Winant 1994). Incoporating racialization into research design can not only help population health researchers understand the health effects of Muslim racialization in a post-2001 social environment, but it also can contribute to broader theoretical understandings of the links between racism, discrimination, and health within and across populations.

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Ethical approval

This article does not contain any studies with human participants performed by the author. Due to the sensitive nature of the records, a data security protection plan was developed by the author and the protocol was approved by the Committee for the Protection of Human Subjects of the California Health and Human Services Agency and the California State Registrar.

CRediT authorship contribution statement

Elyas Bakhtiari: was the sole author for this manuscript.

Declaration of competing interest

No potential conflict of interest was reported by the authors.

Appendix

Appendix A1. Matches Between California Birth Records and External SSA List of MENA and South Asian Names

	Percent Matched
Matched first and last name	33.9
Matched first name only	37.8
Matched last name only	13.3
No matches	14.9

Appendix A2. Comparison of Sikh Name Classifications

Model	Term	Estimate	Standard Error
Kaur (Mother)	(Intercept)	0.061	0.012
Kaur (Mother)	Post-9/11	0.037	0.016
Kaur (Mother) or Singh (Father)	(Intercept)	0.070	0.010
Kaur (Mother) or Singh (Father)	Post-9/11	0.026	0.014
Kaur (Mother) or Singh (Mother or Father)	(Intercept)	0.069	0.009
Kaur (Mother) or Singh (Mother or Father)	Post-9/11	0.024	0.013
Kaur (Mother) or Singh (Father) or Common Sikh Given Name	(Intercept)	0.069	0.009
Kaur (Mother) or Singh (Father) or Common Sikh Given Name	Post-9/11	0.024	0.013

Table compares models with different name-matching criteria for identifying likely Sikh mothers. Alternative specifications that include the father's surname increase the sample size but likely reduce the accuracy of identifying the mother.

Appendix A3. Effect Size By MENA and South Asian Name Uniqueness
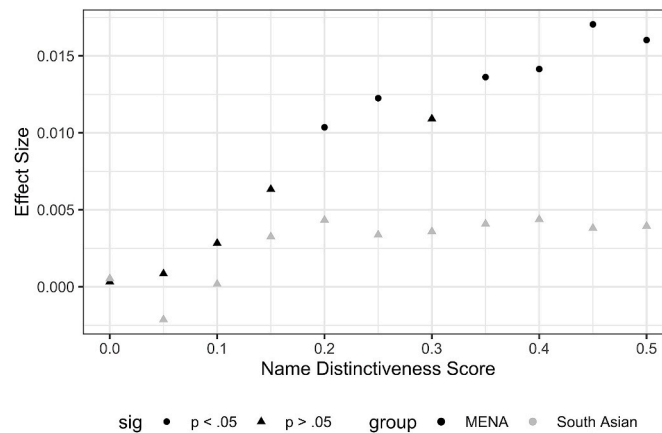
Points represent effect sizes from regression models using varying thresholds of name distinctiveness scores calculated based on the proportional representation of MENA or South Asian immigrants with a name. Higher scores indicate a name is more distinctively MENA or South Asian.

Appendix A4. Quarterly Trends in Reported Anti-Muslim Hate Crimes In California, 1997–2010

Based on data from the Federal Bureau of Investigation's Uniform Crime Reports.

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