LOW BIRTH WEIGHT INEQUITIES IN CONTEXT: RACIAL SEGREGATION, NEIGHBORHOOD FACTORS, AND PRECONCEPTION CARE

BY

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Dedication

I dedicate this work, first and foremost, to my incredible family: my son, Wesley, and my husband, Bryan. Without you, I would never have come this far. You keep me motivated when things seem impossible, give me a reason to smile, and keep me grounded in the things that matter the most. You never doubted me, and you always supported me, and most important, love me, and for this I am eternally grateful.

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Finally, I dedicate this work to the women of California, whose pregnancies and children are the subject of this analysis, and to all underserved women, whose voices we must begin to hear and understand in order to eliminate inequities in birth outcomes and help each woman, child, and family realize their best possible future.

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ABSTRACT

Low Birth Weight Inequities in Context:

Racial Segregation, Neighborhood Factors, and Preconception Care

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Black women experience disproportionately higher rates of low birth weight, preterm delivery, and infant mortality. At least some amount of this disparity results from differences in exposure to detrimental social factors. Segregation is one social force shaping the distribution of power and resources and, therefore, women's exposure to negative social environments. Using data from California Vital Records and the US Census, paper 1 evaluates the relationship between racial isolation and low birth weight for black, Hispanic, and Asian/Pacific Islander women. Isolation from whites predicts higher risk of low birth weight for black women specifically through an increased risk of small for gestational age births. For Hispanic women, isolation from whites predicts and increase in low birth weight for US-born women, but not foreign-born women, suggesting that ethnic enclave effects may not persist in this group. Finally, for Asian/Pacific Islander women, isolation predicts lower risk of low birth weight as a result of decreased risk of appropriate for gestational age preterm birth.

Social capital is one mechanism through which segregation may impact birth outcomes. In Paper 2, analyses using data from California Vital Records and LAFANS suggest that higher levels of perceived social reciprocity are associated with lower risk of low birth weight for foreign-born women, but not for US-born women. Reciprocity predicts higher rates of low birth weight for Hispanic women, indicating that social reciprocity may be a unique stressor for US-born Hispanic women. For black women, social capital measures did not predict low birth weight outcomes.

Paper 3 explores the potential for preconception care – a proposed public health intervention – to alleviate racial inequities in pregnancy outcomes. Preconception care may have positive impacts on individual women's health. However, preconception care utilizes a clinical, individualistic, non-specific approach that does not address either the clinical or social drivers of racial inequities in birth outcomes, and should be reconsidered as a strategy for reducing these gaps. Taken together, these analyses provide insight into inequities in birth outcomes for women of color living in segregated neighborhoods, and evaluate policies aimed at mitigating this disparity.

CHAPTER 1:

Low Birth Weight, Segregation, and Public Health Approaches to Racial Inequities

Background

Despite persistent attention from the public health and clinical communities, the rate of poor birth outcomes – infant mortality, preterm birth, and low birth weight – in the United States remains elevated above those of other industrialized democracies (Martin et al., 2008; U.S. Department of Health and Human Services, 2000). As the leading cause of death among non-Hispanic black and Hispanic infants, and the second-leading cause of death among non-Hispanic white infants, complications related to short gestation and low birth weight represent a significant clinical and public health issue (Martin et al., 2008). Furthermore, racial inequities in birth weight and infant mortality have persisted even as total infant mortality declined and prenatal care utilization among non-Hispanic blacks and Hispanics increased (J. W. Collins & David, 2009; Martin et al., 2008).

While rates of low birth weight for Hispanic women considered en bloc are similar to or lower than those of white women, when the various countries of origin of Hispanic women are considered as distinct subgroups, differences in rates emerge; this is especially true for Puerto Rican women, who birth outcomes are poorer than other Hispanic subgroups' (Osypuk, Bates, & Acevedo-Garcia, 2010). For black women, on the other hand, rates of low birth weight are consistently twice as high as for white mothers. Moreover, low birth weight is the driving factor in black-white disparities in infant mortality rates (J. W. Collins & David, 2009). For those infants who survive, low birth weight carries an increased risk of long-term disability and adult chronic disease

(Conley, Strully, & N. G. Bennett, 2003). Reducing both the incidence of and racial inequities in low birth weight remains a top public health priority because of benefits to individual infants, mothers and families, and to society (U.S. Department of Health and Human Services, 2000).

In an effort to explain racial disparities in low birth weight outcomes, research has begun to link disparities in social context to disparities in health, including birth outcomes. Link and Phelan theorized that certain social-environmental circumstances are "fundamental causes" of health outcomes; even as the types and mechanisms of disease change through time, these circumstances consistently predict health outcomes (Link & Phelan, 1995). For example, whether heart disease or influenza is the most prominent killer of an era, economic prosperity has always predicted mortality. Collectively, these population-based fundamental causes are often referred to as social determinants of health. The social determinants of health drive the distribution of power and resources for health along racial, income, educational, and/or gender lines, resulting in health outcomes disparities between racial minorities and whites, the wealthy and poor, educated and un-educated, and women and men. These social forces often contribute to health outcomes in an indirect manner; in Link and Phelan's terms, the social determinants of the differential distribution of resources for health put people at risk of risks (1995).

Place Matters: Distributional Landscapes and Racialized Geography

These forces shape, among other things, the places and contexts in which we live. In the US, pubic health attention to social context has often focused on "neighborhood effects," which are loosely defined as the impacts that a person's place of residence might have on their health outcomes. The neighborhood is commonly theoretically understood as a community of people dwelling near one another; however, for analytical purposes it is most commonly defined by boundaries delineated in the US Census (e.g. tract or block group), often due to data constraints (Diez Roux, 2007; Frohlich, Corin, & Potvin, 2001; Pickett & Pearl, 2001). Facets of the social context within a person's neighborhood are often operationalized by aggregating individual level data to create a context-level construct (e.g., proportions of residents in poverty and/or average education data determine the SES of an area), which is then used to predict health outcomes independently of the SES of individuals within that area (Diez Roux, 2007; Frohlich et al., 2001; Macintyre, Ellaway, & Cummins, 2002). Research on neighborhood effects has largely sought to establish the importance of these aggregated contextual effects over and above those of the individuals that reside in a given area (Pickett & Pearl, 2001).

Unfortunately, this line of inquiry has also created a potentially false dichotomy between contextual and compositional effects on health (Cummins, S. Curtis, Diez Roux, & Macintyre, 2007; Macintyre et al., 2002). A compositional explanation of area effects on health contends that similar people (with regard to social/demographic characteristics) tend to live together, and that similar people will have similar health outcomes, regardless of place (Frohlich et al., 2001); thus, neighborhood effects are merely an artifact of aggregation of numerous individuals with disadvantaged personal circumstances. On the other hand, a contextual perspective implies that similar people may have different outcomes if their locations have different characteristics (e.g. a poor person in a wealthy neighborhood will fare better than a similarly poor person in a poor neighborhood) (Frohlich et al., 2001). This dichotomization drives a search for independent effects of context, and fails to capture the interaction between structure and agency. Individuals and groups shape, and are shaped by, their environments in a dynamic process that the search for independent effects of context cannot capture (Cummins et al., 2007; Macintyre et al., 2002). Frohlich et al. argue that the compositional/contextual divide de-contextualizes people within their locations in a way that is analogous to the de-contextualization of lifestyle choices from social structures in the biomedical literature (2001). For instance, the effect sizes in neighborhood studies are often small, which may result either from a greater importance of individual behavioral or other factors, or as a consequence of individual factors acting as mediators of the neighborhood environment on health (Pickett & Pearl, 2001). In other words, the social and physical environment may have a hand in patterning and reproducing certain health behaviors, which then impact health outcomes (Cummins et al., 2007; Diez Roux, 2003; S. Curtis & I. R. Jones, 1998; Frohlich et al., 2001). This reciprocity may also explain the lack of effect in many behavior-change interventions (Syme, 1986).

In addition to the influence of context on patterning, reproducing, or constraining individual health behaviors, researchers have theorized that mediators of the relationship between context and health might include chronic stress, lack of material resources or information, disintegrated social networks, or lack of access to quality health care (Buka, Brennan, Rich-Edwards, Raudenbush, & Earls, 2003; Charreire & Combier, 2009; J. W. Collins & David, 2009; Ellen, 2000; Geronimus, 1996; LaViest, 1989; O'Campo et al., 2008; Schulz, D. R. Williams, Israel, & Lempert, 2002; Yankauer, 1950). These may include material/structural elements such as the quality of housing, schools, and local amenities (Bernard et al., 2007; Cozier et al., 2007; O'Campo et al., 2008); the distribution of physical/environmental threats to health (e.g. lead, air pollution) (Schwartz, 1999); social relationship elements such as the maintenance of social networks or the existence of social isolation (Sampson, Morenoff, & Earls, 1999; Szreter & Woolcock, 2004; Uchino, Cacioppo, & Kiecolt-Glaser, 1996); the distribution of access to health care (Grady & Ramírez, 2008); or the availability of services (police, fire, trash), and consequences thereof (increased or decreased violence, fires, or sanitary conditions) (Wallace, 1990). Many of these pathways are hypothesized to harm health through either direct exposure to toxicants, a change in biomedical risk factors (e.g. blood pressure), or via an increase in stress or allostatic load as a result of adverse neighborhood environments.

Drawing upon advances in critical geography, Cummins et al. suggest that a dynamic, multi-scale, layered vision of place will better capture the interplay of place and health (2007). Within this framework, resources and populations are mobile in space and time, and aspects of places are defined in relationship to each other and to 'actors,' who take the form of various animate and inanimate forces, from individuals to businesses to governments, families and peer groups to community organizations to institutions, and policies, cultures, norms, and events. The resources (of all kinds) available to individuals are produced in part by geographical/physical distributions of material assets, but also by social networks and power structures, the actions of 'actors', and the intervention of regulations (Cummins et al., 2007). Places both shape and are shaped by these actors; for instance, the ghetto is not simply a static location, but a dynamic, symbolic place that results from the intersection of race, class, politics, history, and geography (Sundstrom, 2003). The ghetto, the barrio, and the ethnic enclave are all examples of segregated places defined and shaped by relationships between the place itself, the individuals who live there, and wider social, economic, and political forces.

To illustrate this relational concept of place, we describe place as a distributional landscape: a dynamic, multi-dimensional topographical map that distributes the resources – physical, economic, social, political, and emotional – that pattern individuals' and groups' life choices and life chances. Using the terms 'life choices' and 'life chances' specifically invokes the Weberian construction of these concepts, meaning that both the opportunities that arise and the choices one makes about them are a result of individuals and groups in negotiation with the constraints or advantages of the social environment.

Individuals, groups, and institutions navigate and respond to this distributional landscape via social practice, through which they create meaning and utilize available resources; they are constantly reshaping the landscape as they do so (S. Curtis & I. R. Jones, 1998; Frohlich et al., 2001; Popay et al., 2003). Other local and global forces (e.g. school busing or federal tax policy) exert their influence on the topography of the landscape as well, stretching and bending it, raising up peaks and deepening valleys (Cummins et al., 2007). The local topography may enable or discourage the accrual of layers of resources. The resources accrued at any one point in the landscape affect and are affected by the shape of the landscape both locally and globally – this relational dependency speaks to the multi-scale/multi-level impacts of place on health (Cummins et al., 2007; Diez Roux, 2007). The topography constantly undergoes remodeling as it shapes and is shaped by individuals, groups, and the over-arching political, social, and economic conditions.

As a concrete example with relevance to segregation, consider a topographical map of a mountainous area – somewhat counter-intuitively, consider the high peaks as areas of disadvantage, and valleys as representing advantaged areas. In a landscape shaped by historic black-white segregation (among other forces), high peaks represent areas consistent with economic disinvestment, white flight, and social isolation. These peaks would be characterized by the intersection of poor access to resources on a number of fronts – material, social, economic, and environmental. As one travels away from the peak, the qualities of the intersecting landscapes change – perhaps leading us to a poor white neighborhood in one direction (perhaps with access to better foods or better policing), or a middle class black neighborhood in another (perhaps with better quality housing or lower exposure to toxic chemicals). The same forces will have created valleys of advantage in the landscape. One might imagine various types of resources – material, social, political, economic, emotional – as viscous liquids that travel across the surface of this distributional landscape. The topography of the landscape dictates the accrual of resources – resources move away from peaks and accumulate in the valleys. The weight of these resources, or their movement across the region, can act as a glacier or a flood, reshaping the mountains and valleys.

Introducing individuals and groups onto this stylized map, one can imagine the construction of social networks – tightly knit or loosely held together across various areas in the landscape. In a poor, segregated Hispanic neighborhood (e.g. near a peak), one might imagine a tightly knit social network associated with identity, social control, and an affinity for place that serves as a "net" or "fence," capturing and allowing resources to accrue despite topography. As resources accumulate, the weight of these resources might change the topography itself, forming a depression that increases the accrual of resources. Or, in the face of other, stronger forces shaping the topography (for instance, zoning policies prohibiting business investment in the area), the weight of these accumulated resources may instead stretch the network to its breaking point, leaving holes through which available resources drain away.

Racialized Geography

Over a century ago, WEB DuBois wrote that the "problem of the color line," isolates African Americans from resources and contributes to poor relationships between races; for DuBois, segregation was the main problem to be solved in improving race relations. The "problem of the color line" is that race and place – and the advantages and disadvantages that entails – are inextricably intertwined, creating a racialized geography that characterizes the distributional landscape of urban neighborhoods in the United States (Sundstrom, 2003; Yerger, Przewoznik, & Malone, 2007). In fact, the power that segregation exerts over the shape of opportunity and resources in urban US neighborhoods has led some to conclude that segregation is a fundamental cause of racial disparities in health (D. R. Williams & C. A. Collins, 2001).

African Americans have been, at various points in history, excluded both de jure and de facto from living in certain areas (Du Bois, 1903; Massey & Denton, 1993; Wilson, 1990). Massey and Denton's American Apartheid and Wilson's The Truly Disadvantaged explore the structural, social, economic, and individual drivers and consequences of the racial isolation African Americans have experienced for generations (1993;1990). In the aftermath of the Civil War, blacks migrated northward in search of jobs and escape from overt racism; this trend intensified in the first half of the 20th century with increased availability of manufacturing jobs, and blacks moved into northern and Midwest cities to work in the automobile and other industries. Redlining, racial steering and restrictive covenants were commonplace tactics to restrict blacks' access to real estate in certain areas; consequently, African Americans found themselves able to live only in certain parts of the city, areas frequently supported largely by industry (Massey & Denton, 1993).

Mass migration to areas with jobs led, in some areas, to overcrowding and lack of affordable and decent-quality housing (Fine, 2007). Industry began to vacate urban centers for cheaper rent and cheaper labor, and urban redevelopment efforts disrupted established neighborhoods; coupled with ongoing white flight and race riots such as the Watts uprising in Los Angeles or Detroit's 12th street riot, these events led to the further concentration of race and poverty in urban centers (Fine, 2007; Massey & Denton, 1993; Wilson, 1990). As employment opportunities, businesses, and the tax base dwindled, educational opportunities suffered as well. Over time, lack of education and job opportunities, crime, violence, and poverty have reinforced the disadvantage of racially segregated areas (Massey & Denton, 1993; Wilson, 1990). Residential segregation, as a physical manifestation of intentional racial isolation, creates and maintains the separation of African Americans from resources – social, economic, and political. Indeed, Massey and Denton argue that without the framework of racial residential segregation, the changes in the structure of the US economy in the latter half of the previous century (e.g., loss of manufacturing jobs, etc.) would not have had such a massively destructive impact on black neighborhoods (1993).

Massey and Denton identified blacks' experience of multi-dimensional segregation (termed hypersegregation) as unique among racial and ethnic groups; in the 1990s, blacks in many cities were highly segregated on most, if not all, of the 5 dimensions of segregation Massey and Denton identified (1988, 1989). In contrast, Hispanics in this same analysis were moderately or highly segregated on one or two dimensions in some cities, but did not experience the multi-dimensional segregation that was a hallmark of black American's residential experiences. In the same time frame, the segregation of Asian Americans was even lower than that of Hispanics'.

However, the landscape of racial and ethnic segregation may be changing, especially in cities with high proportions of multiple racial and ethnic groups such as Los Angeles. When measured at the metropolitan level against the distribution of white residents, blacks' segregation has slightly declined in many cities, while segregation of Hispanics has increased, particularly in cities with large numbers of Hispanic residents. Asians' separation from whites has remained low to moderate overall (Charles, 2002; Massey & Denton, 1989). At least some portion of the increase in residential segregation for Hispanic and Asian Americans stems from increases in immigration; both the increase in the proportion of residents from a given racial or ethnic group and the typical settlement patterns of recent immigrants (e.g., moving to an area where a group from the same country of origin resides) contribute to rising segregation for racial and ethnic groups with high immigration rates (Charles, 2009).

It is important to note that the history of segregation for both Hispanic and Asian racial and ethnic groups has a distinctly different nature from that of segregation for African Americans; with its roots in slavery and the African diaspora, and, after emancipation, legally-enforced separation, the experience of blacks in the US is characterized by a centuries-long history of oppression and forced isolation to undergird it. On the other hand, the history of Hispanic and Asian Americans' experiences with residential segregation in the US is relatively shorter and more regionally confined (e.g., Chinese immigrants in California working on the transcontinental railroad in the mid-1800s; Mexicans living in the southwest subsumed by the US as a result of the Mexican-American War in the mid-1800s). Furthermore, exclusionary immigration practices drastically reduced the numbers of non-European immigrants who could enter the US from the late-1800s until 1965, when the Hart-Cellar Act removed nationality-based quotas (Takaki, 1989). Though immigration laws had less effect on Hispanic migration, large numbers of Hispanics were forced out of the southwest between the late-1800s (immediately following the Mexican American War) and the mid-1940s (the beginning of the second World War) (Estrada, García, Macías, & Maldonado, 1981). During the Civil Rights movement, the Hispanic population finally began to gain recognition (Estrada et al., 1981).

This is not to diminish the often-brutal oppression Hispanic and Asian groups faced, but rather to point out that these groups came to the US under different auspices (e.g., not as slaves – though frequently exploited as cheap labor), were confined to smaller regions of the country, and lived in the US in smaller numbers than African Americans, so their experiences with segregation and racial oppression are necessarily different. In geographic regions with higher concentrations of Asian and Hispanic racial and ethnic groups, immigrant settlement patterns have contributed to the formation of so-called immigrant enclaves, which are largely segregated from residents of other nationalities or races. Some researchers have suggested that Asians and Hispanics experience a largely transitional relationship with this type of segregation. That is, they live in segregated neighborhoods during a time of assimilation, at which point they gain access to more integrated neighborhoods and resources by virtue of increased identification with US culture and improving economic circumstances (for review, see: (Charles, 2009)). Furthermore, it is argued, these ethnic enclaves may play a positive role in immigrants' lives, offering them a strong social network and a buffer against the chaotic nature of moving to a new county (Finch, Lim, Perez, & Do, 2007).

Taking this further, some scholars claim that present-day racial segregation, regardless of race, ethnicity, or nativity, owes more to racial preferences for own-group neighbors than to racial discrimination on either an individual or institutional level (W. A. V. Clark, 1991). Studies of racial preferences for neighbors using show-card surveys have identified an opposing trend, however. Though individuals typically prefer at least some own-group neighbors, African Americans are most likely to prefer a mixed-race neighborhood over an entirely own-group neighborhood, while whites are least likely (Bobo, 2000; Charles, 2009; Farley, Fielding, & Krysan, 1997; Farley, Steeh, Krysan, Jackson, & Reeves, 1994). Furthermore, the LACSUI study of racial preferences among Los Angeles residents identified a hierarchy of preference with whites at the top (all groups preferred to live with whites), Asians and Hispanics in the middle (in the stated order), and African Americans at the bottom (groups would choose any other race/ethnic group as neighbors over African Americans) (Charles, 2002, 2009). Computational modeling suggests that these racial preferences alone are not enough to create the level of segregation that exists in many urban areas; a combination of price restriction (e.g., inequalities in access to housing) and racial preference is required to achieve high levels of segregation (Bruch & Mare, 2006). Data also suggest that discrimination results in blacks paying more for entrance into white neighborhoods than a similarly situated white person might. Though the Fair Housing Act of 1968 ostensibly ended de jure housing discrimination, data from audit studies suggest that lenders and real estate brokers practice subtle forms of racial steering and redlining that flaunt the spirit, if not the letter, of the 1968 law. In these studies African Americans, Hispanics, and Asians all experienced housing discrimination in the form of refusal to show (or admit to having) available units, extended wait times, lack of follow-up, assumptions about creditworthiness, and mortgage discrimination (Pager & Shepherd, 2008; Turner, 1992).

Taken together, the literature suggests that modern segregation arises from the intersection of racialized housing discrimination, racial preferences (largely against people of color as neighbors), and history. Ongoing isolation contributes to diminished political power, disrupted social networks, and the concentration of disadvantage in neighborhoods where people of color live. The social, economic, and historic forces of segregation result in uneven exposure to the circumstances and processes linking neighborhoods and health. In other words, segregation changes the distributional landscape of power and resources for health – material, social, and structural –

with disadvantaged, segregated racial and ethnic groups generally having lower access to these resources.

Pathways to Birth Outcomes

In Link and Phelan's terms, segregating forces, and subsequently, living in a segregated neighborhood, may put the people who live there at risk of risks for poor birth outcomes. It is clear that the forces of segregation act to shape the distributional landscape and the individuals who navigate and interact with it, resulting in unevenly distributed resources and opportunities related to birth outcomes. Evidence from a growing number of studies suggests that low birth weight is generally associated with black-white residential segregation measured at the metropolitan-area level (Bell, Zimmerman, Almgren, Mayer, & Huebner, 2006; Ellen, 2000; Grady, 2006; LaViest, 1989; Mason, Messer, Laraia, & Mendola, 2009; Pickett, J. Collins, Masi, & Wilkinson, 2005; Reichman, Teitler, & Hamilton, 2009; Yankauer, 1950). However, the mechanisms by which segregation contributes to health disparities are not entirely well understood, especially with regard to the mechanisms by which the circumstances of a segregated neighborhood could "get under the skin" to produce poor birth outcomes (Green & Darity, 2010; D. R. Williams, 2005; Taylor, Repetti, & Seeman, 1997).

Myriad contextual elements of segregated neighborhoods have been implicated in the relationship between segregation and birth outcomes (and, indeed, health outcomes in general). These mirror the general contextual factors related to health that we outlined earlier: lack of material resources, including low quality schools, housing, or amenities; disrupted social relationships, including lack of social support; increased crime or violence; decreased employment or education opportunities; exposure to environmental toxins; decreased access to health care, etc. These realities of living in a segregated neighborhood might impact birth outcomes through three general, potentially interrelated, mechanisms. First, mothers in racially segregated neighborhoods could have higher (or lower) prevalence of health behaviors related to low birth weight (Bell, Zimmerman, Mayer, Almgren, & Huebner, 2007). Racial segregation can help to both create and maintain unhealthy behavior patterns; individual-level behaviors such as smoking or poor nutrition depend to some degree on structural factors that contribute to vulnerability in segregated neighborhoods. For instance, in black neighborhoods, targeted tobacco advertising or a lack of healthy food options may be common phenomena, making it easier to start smoking and/or difficult to choose nutritious foods (Laraia, Siega-Riz, J. S. Kaufman, & S. J. Jones, 2004; Morland & Filomena, 2007; Morland, Wing, & Diez Roux, 2002; Barbeau, Wolin, Naumova, & Balbach, 2005; Luke, Esmundo, & Bloom, 2000; Hackbarth, Silvestri, & Cosper, 1995). These structural elements contribute to the creation and maintenance of health behavior risks for residents of segregated black neighborhoods, suggesting that health behaviors may mediate the relationship between racial segregation and low birth weight.

Second, a growing body of literature finds that living in a segregated neighborhood increases residents' likelihood of exposure to environmental toxins (e.g., lead, air pollution (Morello-Frosch, Jesdale, Sadd, & Pastor, 2010). Many of these toxins have theoretical or empirically-demonstrated influence on the growing fetus, causing congenital defects, low birth weights, or ongoing behavioral problems in children. Diminished political power and lower property values can mean that segregated neighborhoods more frequently become targets for freeways, industrial activities, or other sources of pollution that might increase pregnant mothers' exposure to these toxicants.

Aside from direct exposure to toxins or health behaviors, however, the vast majority of the hypothesized pathways from segregation to birth outcomes invoke exposure to stress (either chronic or acute) as the principal link between the two. Chronically stressful circumstances may stem from systematic disinvestment in racially segregated areas; for instance, women living in segregated neighborhoods may face poor employment prospects, and may therefore face financial instability as a single head of household (LaVeist, 1993; D. R. Williams & C. A. Collins, 2001). Social isolation or lack of social cohesion, fear of violence or crime, or financial or residential instability may create stressful situations that could negatively impact pregnancy (Buka et al., 2003; Culhane & Elo, 2005; Diez Roux, 2003; O'Campo et al., 2008; Sampson et al., 1999; Szreter & Woolcock, 2004). Perhaps the best-known epidemiological test of this association is via Geronimus' "weathering hypothesis," which posits that the broader social context in which black women live (including experiences with discrimination, financial difficulty, single motherhood, employment difficulties, and neighborhood environment) translates into a chronic stress response that has an adverse effect on health and well-being (1996). Theoretically, this chronic exposure ages the body prematurely and impairs biological systems; in the context of pregnancy, this translates to poorer pregnancy outcomes for black women at earlier ages than their white counterparts (and to better outcomes for African American women who have children very early as compared to later childbearing) (Geronimus, 1996; Geronimus, Hicken, Keene, & Bound, 2006).

Furthermore, African American women's pregnancies occur at the intersection of race, gender, and class, which opens another unique avenue for psychosocial stress during black women's pregnancies. Historical devaluation and hypersexualization of black women's reproduction and bodies – beginning with the use of female slaves as breeders and continuing through to present-day Medicaid forced sterilization scandals – contributes to stereotypes of black women as promiscuous, incapable mothers (Roberts, 1999). Black women may particularly feel the impact of these stereotypes when pregnant themselves; stereotype threat occurs when individuals feel that they may inadvertently reinforce negative stereotypes, and black pregnant women may feel considerable self-conscious anxieties and stress regarding others' perceptions of them as their pregnancies become visible (Rosenthal & Lobel, 2011; Dominguez, 2011; Ginsburg & Rapp, 1995).

Though we have thus far concentrated on the negative aspects of segregation, sociologists point out that it need not always have detrimental effects. In segregated neighborhoods where social processes contribute positively to women's social and emotional well-being, segregation may be linked to health resiliency as opposed to poor birth outcomes (Finch et al., 2007). For instance, if segregated neighborhoods provide increased social support, they may also exert social control with regard to high-risk behaviors during pregnancy (e.g. poor food intake). In addition, improved social support may reduce the burdens of financial instability, or improved social control may increase neighborhood safety, both of which could reduce stress and the likelihood of poor pregnancy outcomes.

Studies have only begun to assess the relationship between segregation and non-black racial and ethnic groups. Within the Hispanic community, one study finds that recent immigration status may interact with metropolitan-area segregation, creating a protective association between Hispanic segregation and birth weight outcomes for recent immigrant women (Osypuk et al., 2010). Sociologists and epidemiologists have extensively documented the “Hispanic paradox,” whereby recent Mexican immigrant mothers have lower rates of poor birth outcomes than either their US-born counterparts or non-Hispanic whites in the US, despite generally lower socioeconomic status (see, for example, (Landale, Oropesa, & Gorman, 2000). This phenomenon likely results from the interplay of healthier women immigrating to the US and delayed assimilation that results from settling among other individuals from their country of origin (Landale et al., 2000). Voluntary isolation from US culture may offer a protective barrier against the stressors of immigration and diminished socioeconomic resources, which could improve birth outcomes. Among Asian Americans, Walton finds that metropolitan-area measures of segregation may decrease the likelihood of low birth weight, evidence suggesting there may be a “supportive ethnic enclave” effect for Asian women (2009).

Segregation is inherently spatial, but many of the studies linking birth outcomes and segregation do not place individual mothers in the neighborhoods in which they live; rather, they associate individual level birth outcomes with metropolitan-wide measures of segregation. While useful for beginning to understand populations at risk, this approach cannot fully capture the racial isolation or diversity of an individual mother’s neighborhood or how it might be associated with her pregnancy outcomes (Diez Roux, 2007; Reardon, 2006; Reardon & Firebaugh, 2002; Reardon & O’Sullivan, 2004; Reardon, Yun, & Eitle, 2000). Under ideal circumstances, segregation is most appropriately measured by considering each individual mothers’ neighborhood and its surroundings (e.g., bordering neighborhoods) rather than by the metropolitan area or a single neighborhood.

Some have argued that racial segregation simply serves as an indicator of economic segregation (Hearst, Oakes, & P. J. Johnson, 2008; Messer, Oakes, & Mason, 2010). However, sociologists demonstrate that the circumstances of racially segregated black neighborhoods differ from those of white neighborhoods at similar socioeconomic levels (Alba, Logan, & Stults, 2000; Massey, 1990; Oliver & Shapiro, 1995; Pattillo, 1999). This means that residents of black middle class neighborhoods, while separate from poor black neighborhoods, are more proximate to negative contextual factors and have fewer resources in their vicinity than middle class whites. For Hispanic and Asian families, this trend is less clear, with socioeconomic status playing a somewhat more important role in the segregation of these groups from their white counterparts (Charles, 2009). A few studies have demonstrated that, at least for black-white segregation, associations with low birth weight are independent of tract-level income or even spatially-measured economic segregation (Debbink & Bader, 2011; Grady, 2006).

Low Birth Weight: Etiologies and Implications

Biomedically speaking, the physiological pathways leading to low birth weight are not particularly well understood, but placental vascular pathology, intrauterine infection, and abnormal (non-microbial) activation of the neuroendocrine pathway leading to labor are all thought to play a role (for a review, see (Faye-Petersen, 2008)). Clinical and epidemiological literature documents the importance of maternal demographic factors (race, younger and older maternal age, and low socioeconomic status), previous preterm deliveries or low birth weight deliveries, smoking, depression, poor maternal nutrition and low pre-pregnancy weight, and maternal morbidities (gestational diabetes, hypertension, etc) for low birth weight outcomes (for review, see (Goldenberg, Culhane, Iams, & Romero, 2008)). The relationship between these predictors and the physiological mechanisms leading to low birth weight is still under study; tobacco exposure, for instance, causes both a systemic inflammatory response and powerful vasoconstriction which might decrease placental blood flow, and either or both of these conditions might contribute to low birth weight (Goldenberg et al., 2008).

While the evidence linking stress directly to low birth weight still has significant gaps, studies have demonstrated that both self-reported social or psychological stress and exposure to “objectively” stressful life events are associated with dysregulation of the endocrine pathways leading to labor and birth (Faye-Petersen, 2008). Epidemiologists and clinicians have also begun to document the relationship between maternal stress and suspected precursors to bacterial vaginosis (a potential precursor to intrauterine infection), and potentially to vascular pathology in the placenta (Culhane & Elo, 2005; Faye-Petersen, 2008).

Contributing to the complex biomedical picture of low birth weight is the fact that most social epidemiological studies consider low birth weight in a monolithic way; however, low birth weight is the outcome of one of two phenomena – early delivery of an infant whose weight is appropriate for gestational age, and intrauterine growth restriction – which are generally considered to have relatively distinct physiological mechanisms (Gabbe et al., 2007; Lu, Tache, Alexander, Kotelchuck, & Halfon, 2003; Villar & Belizán, 1982). Clinical criteria define intrauterine growth restriction (IUGR) as birth weight below the 10th percentile for gestational age, which can occur at any gestational age (Alexander, Himes, R. B. Kaufman, Mor, & Kogan, 1996). IUGR is most often related to low oxygen perfusion of the fetus, which is in turn often related to problems with the blood vessels of the placenta and uterus (i.e. placental and/or vascular insufficiency) (Cetin & Antonazzo, 2009; Gluckman & Harding, 1997; Hendrix & Berghella, 2008; Murphy, Smith, Giles, & Clifton, 2006; Papiernik, 1999). In essence, infants affected by IUGR have reduced access to oxygen and nutrients in utero, which creates a stunting effect and results in a weight that is below the typical growth for gestational age. On the other hand, the biological cascade that can result in an appropriately-grown fetus being born early (e.g., as a result of spontaneous preterm rupture of membranes or preterm labor) is closely connected with infectious processes (Andrews, Hauth, & Goldenberg, 2000; Berkowitz & Papiernik, 1993; Faye-Petersen, 2008; Gibbs, 2001; Goldenberg et al., 2008; Lu et al., 2003; Romero et al., 2001). In the case of spontaneous preterm delivery, a fetus may simply not have had the time to reach 2500g before being delivered; it is not necessarily true that low birth weight as a result of preterm delivery represents a problem with fetal growth.

Of course, infants can both have intrauterine growth restriction and be born preterm; however, it is worth nothing that research suggests that IUGR is itself a risk factor for preterm delivery (e.g., preterm labor may be triggered later in pregnancy by the same pathology which results in IUGR) (Romero et al., 2006; Zeitlin, Ancel, Saurel-Cubizolles, & Papiernik, 2000), and that the clinical management of prenatally-diagnosed IUGR includes induced early delivery (Grivell, Dodd, & Robinson, 2009). Taken together, these two findings suggest that if an IUGR infant is born preterm – whether spontaneously or via induction – IUGR is the driving pathological factor for the infant's low birth weight. Previous epidemiological research has often subdivided low birth weight outcomes into preterm delivery and small for gestational age term deliveries, but we believe this categorization preferences preterm delivery as an explanatory mechanism; based on the evidence, we propose instead to subdivide low birth weight births (i.e., those under 2500g) into small for gestational age (at any gestational age) vs appropriate for gestational age births. Because the clinical cut-off for intrauterine growth restriction is 2500 g at 37 weeks, any appropriate for gestational age infant that weighs less than 2500 g will necessarily also be preterm.

The distinction between intrauterine growth restriction and preterm delivery without intrauterine growth restriction is important for a number of reasons, not the least of which is that infants born small for gestational age have higher likelihood of neonatal death and perinatal morbidity (Bernstein, Horbar, Badger, Ohlsson, & Golan, 2000; Garite, R. Clark, & Thorp, 2004; Kady & Gardosi, 2004). In addition, understanding etiological differences may inform epidemiological and health policy research which seeks to address the incidence of and disparities in low birth weight – if one or the other mechanism is particularly prevalent in certain communities or circumstances, it may provide insight as to the specific biological linkages between those circumstances and low birth weight. For example, one study finds that the linkage between racial segregation and low birth weight may operate through an association with IUGR, which could suggest a more chronic assault on the mechanisms of growth of the fetus as opposed to more acute infectious phenomena (Debbink & Bader, 2011). Additionally, identifying the mechanism of action lends itself to targeted interventions (or provides evidence against others). If a community has a high rate of IUGR (as opposed to appropriate for gestational age low birth weight), for example, a broad-scale screening of all at-risk women for undiagnosed bacterial vaginosis in an effort to identify and treat subclinical infection that might lead to preterm birth may not result in the reductions in preterm birth/low birth weight that could be otherwise expected.

Toward Nuance in Segregation and Birth Outcomes Research

Perhaps the clearest message of the literature (little of which is unequivocal) is that research to date in the field of segregation and birth outcomes has been somewhat hampered by the need to aggregate and decontextualize, a need often driven by data. Both the conceptualization of segregated places and the treatment of low birth weight need further detail in order to establish a clear picture of the association. Indeed, such a picture is necessary if interventions to improve low birth weight disparities at the neighborhood level are to succeed. Segregated neighborhoods, especially for black women, are associated with high risk for low birth weight, and if we seek to address this risk with public health policy and community-based change, a fuller picture of the landscape is required. The persistent nature of low birth weight disparities requires a more detailed understanding of the association between the distributional landscape confronting high-risk, segregated communities and poor birth outcomes that allows for the contextualization of women and their pregnancy experiences (Lu et al., 2003).

Responding to Birth Outcomes Inequities: Preconception Care as Public Health Policy

With this contextualization in mind, we turn our attention to the recent push in public health discourse toward preconception care as a means to reducing low birth weight and eliminating low birth weight disparities. Though current prenatal care offers benefits to mothers and infants, a review by Lu and colleagues suggests that the risk assessment, health promotion, and clinical interventions provided via traditional prenatal care can do little in terms of preventing low birth weight and preterm birth (2003). Clinical interventions to delay delivery have shown mixed effectiveness, and the current treatment for intrauterine growth restriction is early delivery, which allows the provision of external sources of nutrition (Behrman, Butler, & Institute of Medicine (U.S.)., 2007; Grivell et al., 2009). Because prenatal care cannot prevent these adverse events, increases in access to and utilization of prenatal care by women of color has not resulted in decreases in low birth weight disparities. In response, public health attention has recently shifted to preconception and interconception care – initiatives aimed at ensuring that all women who are capable of child-bearing receive primary care, diagnostic screening, and treatment of chronic disease (K. Johnson et al., 2006). On its face, such initiatives have a laudable goal of improving women's health before they become pregnant. However, the frameworks that undergird these initiatives and the questionable improvement one could expect with regard to the incidence of or inequities in low birth weight deserve reasoned critique.

Disease-based public health and clinical approaches such as preconception care focus on individual women and the symptoms they might have, and may address specific problems with a given individual's health or pregnancy. However, such approaches are unlikely to alleviate health disparities on a broad scale because they do not deal with factors, such as segregation, that place women at risk of risks (Link & Phelan, 1995; Marmot, Bobak, & Davey Smith, 1995; Rose, 1985). This may be particularly true for poor birth outcomes; approximately one-half of all preterm births have no discernible precipitating medical condition – indicating that earlier health care is not likely to prevent the early birth (Lu et al., 2003). Furthermore, as the preceding review (and others) suggest, a growing body of evidence implicates social determinants of health such as employment, education, and place of residence in low birth weight outcomes. Unfortunately, however, a continued focus on individualized health care access and health behavior does not address the "population shift" that Rose describes as necessary to move an entire population away from health risk and into health resilience. Individually-based medical interventions can only take us so far in improving the health of populations (Lantz, Lichtenstein, & Pollack, 2007; Tarlov, 1999).

Osypuk and Acevedo-Garcia point out that in order to achieve reductions in racial inequities in low birth weight and infant mortality, we must focus on the factors that differentially impact or uniquely confront African American women (2008). As the preceding sections of this review have demonstrated, many of these factors are social – rather than clinical – in nature. Preconception care's reliance on the clinical encounter and health behavior change as avenues for achieving reductions in poor pregnancy outcomes are likely to fall flat unless women's social context – particularly that of disadvantaged women of color – is explicitly taken into account and targeted for change.

Preconception care first entered the academic literature in the early 1980s; at that time, it commonly referred to counseling appointments for women after an expressed desire to conceive. However, the scope of preconception care has widened in the intervening decades such that in 2006, the CDC issued a report detailing the recommendations of a preconception care task force that included preconception care as a necessary part of care for all women of childbearing age (K. Johnson et al., 2006).

Sociologists have long documented the scope creep which characterizes medicalization; increasingly wider nets are cast, capturing more people, more symptoms, and more disorders under the heading of a "disease" requiring "treatment" (Conrad, 1992). While one may debate the forces that drive medicalization (Conrad, 2005), the existence of the phenomenon is clear; in this case, preconception and interconception care medicalize the entirety of a woman's reproductive life, whether she is healthy or not, or plans to conceive or not. Medicalization is particularly troubling when there are no attendant advances in therapeutic options; individuals become "patients" but have no increased chance of successful treatment or improvement in their condition(s). Evaluating preconception care as an intervention to improve birth outcomes should consider whether it constitutes an advance in treatment that will improve birth weight.

To that point, clinical and epidemiological critiques are warranted to determine the impact such a wide-reaching intervention might actually have. Preconception care literature explicitly states a goal of reducing racial and ethnic disparities in low birth weight (K. Johnson et al., 2006).

However, given the persistence of low birth weight disparities to individualized medical and health-behavior interventions in the past, preconception care faces an uphill battle at best to reverse the entrenched gaps in birth weight outcomes, especially for African American women.

Conclusions

In the following chapters, I endeavor to contribute to our understanding of the contextual drivers of racial inequities in low birth weight and to evaluate a particular policy solution aimed to address those inequities. In Chapter 2, I will explore the relationship between racial segregation and birth outcomes in Los Angeles County; in Chapter 3, I explore how specific neighborhood circumstances, especially as they relate to racial segregation, play a role in low birth weight outcomes and disparities for residents of LA County.

The analyses proposed in Chapters 2 and 3 will seek to address gaps in the literature with regard to understanding the association between residential segregation and birth outcomes, especially as it pertains to inequities in low birth weight for women of color. By measuring segregation at a local level using spatialized indices, these analyses will situate women and their pregnancy outcomes more clearly within the circumstances that accompanied their pregnancies. Focusing on Los Angeles County provides a clear opportunity to begin to disentangle many of the questions facing racial residential segregation research.

First, because of the availability of LAFANS data, these analyses may begin to shed light on which social and material characteristics of neighborhoods might be responsible for the associations between segregation and low birth weight. The LAFANS data offer the opportunity to paint a more nuanced picture of these associations, and the analyses in Chapter 3 will be the first to include detailed neighborhood level data collected outside of the Census in models of segregation and low birth weight. Secondly, the large multi-ethnic population in LA County provides an ideal setting for exploring how racial segregation might vary in its impact on low birth weight across different racial and ethnic groups. Of particular note, no research to date has explored the impact of racial segregation measured at the local level for Hispanic or Asian women. Furthermore, measuring segregation along both of the spatial dimensions identified by Reardon and O'Sullivan – exposure and evenness – offers an opportunity to bring nuance to the theoretical and conceptual models linking segregation and birth outcomes (2004). Finally, by defining and analyzing the impact of segregation on both intrauterine growth restriction and preterm delivery, these analyses may help to bring clarity to the biological drivers of any association between segregation and low birth weight, as well as to more clearly define the clinical and public health challenges that women living in segregated neighborhoods face during pregnancy.

In Chapter 4, I take up the issue of intervention by assessing the recent push towards preconception and interconception care as a means of reducing racial disparities in infant mortality and low birth weight. The push towards preconception care raises concerns from a sociological perspective regarding the medicalization and pathologization of healthy women; from a feminist perspective, regarding placing value on women's health and health care simply because of their role as mothers; and from a clinical perspective, regarding the efficacy of a clinically-based preconception care approach for alleviating inequities in birth outcomes. The exponential increase in literature in this field has not yet met with significant critique in the published literature, though concerns have been raised in other venues.

Taken together, these papers will enhance the field of inquiry in segregation and health, specifically segregation and birth outcomes. Given the persistent nature of birth weight and infant mortality disparities, we must begin to focus on structural elements that uniquely and differentially impact African American women if we are to begin to address the inequalities at the root of low birth weight disparities.

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CHAPTER 2:

THE PROBLEM OF THE (SHIFTING) COLOR LINE:

RACIAL/ETHNIC SEGREGATION AND LOW BIRTH WEIGHT IN LOS ANGELES COUNTY, 2000-2004

Introduction

Poor pregnancy outcomes – infant mortality, preterm birth, and low birth weight – reflect not only the health and well-being of individual mothers and children, but also the well-being of communities and societies. Infant mortality and low birth weight rates often mirror the health, economic prosperity, educational level, and standard of living of the community; thus, they are of interest not only to organizations and officials interested in public health, but also to entities that often focus more closely on economic issues (Petros-Barvazian & Béhar, 1978; World Bank, 2003; World Health Organization, 2009). Differences in pregnancy outcomes are evidence of inequities in the opportunity for and availability of resources to protect and promote health – that is, birth outcomes disparities represent unequal life chances (Messer, J. S. Kaufman, Mendola, & Laraia, 2008; Sastry & Hussey, 2002).

In the US, despite persistent attention from the public health and medical communities, the rate of poor birth outcomes exceeds that of other industrialized nations (MacDorman & Mathews, 2009). Problems of low birth weight and short gestation are the leading cause of neonatal mortality for non-Hispanic Black and Hispanic infants (J. W. Collins & David, 2009); low birth weight babies who survive the early neonatal period have a higher likelihood of poor health and social outcomes throughout their lives (Behrman, Butler, & Institute of Medicine (U.S.)., 2007; Conley & Bennet, 2000; Conley, Strully, & Bennett, 2003). Furthermore, striking disparities exist between the rates of low birth weight among infants born to non-Hispanic Black mothers, which are twice those of infants born to mothers from non-Hispanic White, and Hispanic racial and ethnic groups (J. W. Collins & David, 2009; Martin et al., 2008). Epidemiologic research has found that while individual characteristics (e.g., mother's age, parity, education, prenatal care access and utilization, and smoking, among others) can explain some of the differences between African Americans and Whites, they cannot fully explain the disparities (Alexander, Kogan, Himes, Mor, & Goldenberg, 1999; Chomitz, Cheung, & Lieberman, 1995; Goldenberg et al., 1996; Shiono et al., 1995). Furthermore, socioeconomic status alone cannot explain the gap in birth outcomes between Black and White women; African American women at every level of socioeconomic status have higher rates of adverse pregnancy outcomes than those of their White counterparts (Krieger, 1991). In light of this, researchers have begun to examine social and contextual factors that might contribute to the inequity in birth weight outcomes between Black and White mothers.

Racial residential segregation is an important element of social context reflecting the opportunity structures to which racial and ethnic minorities have access. Over a century ago, DuBois recognized "the problem of the color line" as central to the distribution of resources for prosperity and a barrier to improved interracial relations (1903, p. 127). A result of historical, social, and political forces, contemporary racial segregation in the United States embodies the intersection of race and class in urban neighborhoods (Massey, 1990; Wilson, 1990). The isolation of people of color from Whites limits access to material and social resources, quality education, and employment (Massey, 1990). For Black Americans, the multi-generational impact of segregation has led to less accumulated wealth, penalties for homeownership (Charles, 2002), and, overall, residence in less affluent neighborhoods than individuals of other races with similar income (Charles, 2002; Pattillo, 1999).

Racialized Geography and Birth Outcomes

Critical urban geographers use the term racialized geography to describe the isolation of segregated urban neighborhoods (Sundstrom, 2003). This geographic reality – the spatial separation of racial groups from one another – influences the distribution of material, social, and structural resources for health, with disadvantaged, segregated racial and ethnic groups generally having lower access to these resources. In Link and Phelan's terms, segregating forces, and subsequently, living in segregated places, may put women at risk of risks for poor birth outcomes (1995).

A growing body of literature has linked residential isolation among African Americans to poor health outcomes, including all-cause mortality (Acevedo-Garcia & Lochner, 2003; Williams & C. A. Collins, 2001) and low birth weight (Bell, Zimmerman, Almgren, Mayer, & Huebner, 2006; Ellen, 2000; Grady, 2006; LaViest, 1989; Mason, Messer, Laraia, & Mendola, 2009; Pickett, J. Collins, Masi, & Wilkinson, 2005; Reichman, Teitler, & Hamilton, 2009; Yankauer, 1950). Though the mechanisms have not been fully tested, segregated neighborhoods are hypothesized to affect low birth weight through several potentially interrelated pathways. For instance, segregated neighborhoods often have lower quality housing, schools, policing, and local amenities (Bernard et al., 2007; Cozier et al., 2007; Morenoff, 2003; O'Campo et al., 2008). Segregated areas typically have fewer and poorer quality grocery stores (Morland & Filomena, 2007; Morland, Wing, Diez Roux, & Poole, 2002); poor nutrition, in turn, may contribute to small for gestational age births and to gestational diabetes, which can increase the number of congenital defects in infants. Segregation also directly influences the distribution of physical and environmental toxins that threaten health (e.g. lead, air pollution), some of which may result in low birth weight (Morello-Frosch & Lopez, 2006; Morello-Frosch, Jesdale, Sadd, & Pastor, 2010; Schwartz, 1999). Health care access may also be a problem, with lack of physicians or clinics and inability to access services implicated in reduced access to health and prenatal care in segregated neighborhoods (Grady & Ramírez, 2008).

Neighborhood quality can affect social relationships, including the maintenance of social networks or the creation of social isolation, which may either directly or indirectly impact health through knowledge exchange, health behavior alteration, social support, and social stress (Sampson, Morenoff, & Earls, 1999; Szreter & Woolcock, 2004; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Finally, it is also possible that living in a segregated neighborhood may create and maintain risky health behaviors. For instance, tobacco and alcohol advertising is often targeted towards segregated neighborhoods (Barbeau, Wolin, Naumova, & Balbach, 2005; Hackbarth, Silvestri, & Cosper, 1995; Luke, Esmundo, & Bloom, 2000; Yerger, Przewoznik, & R. E. Malone, 2007), and African American women living in segregated areas are more likely to smoke that those who live in more integrated areas (Bell, Zimmerman, Mayer, Almgren, & Huebner, 2007).

While some of these pathways represent purely exogenous impacts on birth outcomes (e.g., exposure to toxicants), many invoke the accumulation of, or chronic exposure to, stress as the mechanism translating neighborhood circumstance into pregnancy outcomes. Geronimus' "weathering hypothesis" suggests that the chronic stress African American women often face, accumulated over a lifetime, may prematurely age the body, thus contributing to poorer pregnancy outcomes (1996). Furthermore, the psychosocial stresses associated with identity at the intersection of gender and race may contribute additional stress around the time of pregnancy for African American women; that is, the devaluation of Black women's reproduction and a self-awareness of this devaluation may contribute additional and unique stresses to Black women's pregnancy experience (Ginsburg & Rapp, 1995; McCormack, 2005; Roberts, 1999; Rosenthal & Lobel, 2011).

The New Racialized Geography and Birth Outcomes

Sociologists and social epidemiologists have observed that segregation need not have exclusively negative impacts (Grady & McLafferty, 2007). Although Black isolation from Whites remains high, the nature and distribution of racial segregation in the US is changing, especially in cities with larger populations of multiple racial groups (e.g., Hispanic, Asian, and other groups) (Charles, 2009). Among more recently-immigrated groups, in fact, residence in neighborhoods with high co-ethnic concentration is common and may provide a buffer against the jarring nature of moving into an entirely new culture, language, and social circumstance. Hispanic and Asian Americans, on average, have pregnancy outcomes similar to or better than their White counterparts, despite generally lower socioeconomic status and access to resources (especially among Hispanic women) (Martin et al., 2008; Sparks, 2009); some have hypothesized that the existence of so-called ethnic enclaves may provide important social and economic supports that protect pregnant women in these communities from the stressors that could contribute to poor pregnancy outcomes (Finch, Lim, Perez, & Do, 2007; Osypuk, Bates, & Acevedo-Garcia, 2010). This may be particularly important for immigrant women: The "immigrant paradox" – whereby recent Mexican immigrant women's birth outcomes are better than their US-born Mexican counterparts' – is extensively documented in the literature, and it is suggested that US-born Mexican women's birth outcomes decline with increased acculturation (Callister & Birkhead, 2002; Finch et al., 2007; Landale, Oropesa, & Gorman, 2000).

While most previous work on segregation and health has focused on African Americans' experiences, three recent studies have sought to investigate how racial segregation, as experienced by other ethnic groups, might affect birth outcomes (Grady & McLafferty, 2007; Osypuk et al., 2010; Walton, 2009). These studies find that segregation may be protective for Hispanic and/or Asian American mothers, and that nativity may also play a role in the relationship between segregation and birth outcomes for these communities.

Measuring Segregation and Birth Outcomes

Whether describing African American, Hispanic, or Asian communities, with few exceptions (Debbink & Bader, 2011; Grady, 2006), research in this area utilizes metropolitan-area measures of segregation or neighborhood level racial composition to assess the relationship between racial residential isolation and birth outcomes. However, isolation is inherently spatial; thus, understanding how the racial isolation of an individual mother's neighborhood can impact her pregnancy outcomes requires measuring that isolation at the local, neighborhood level. Measuring segregation by considering the racial makeup of a mother's neighborhood and its immediate surroundings (e.g., bordering neighborhoods), provides a more complete picture of segregation at the neighborhood level than do measures which capture metropolitan area segregation or the racial composition of a single neighborhood (Grady, 2006). In other words, one would expect the health impacts of racial segregation to depend most closely on the mother's experience of her local neighborhood as situated within neighboring areas, which implies that we should measure segregation using neighborhoods as the unit of observation.

Furthermore, racial segregation at the local level has most prominently been measured as the isolation of one group in question from another. Massey and Denton's five measures of segregation include evenness, exposure, concentration, centralization, and clustering (1988). Of the few studies that examine the association between local racial residential segregation and health, all use an adaptation of Massey and Denton's exposure (i.e., isolation) measure to assess neighborhood segregation. To our knowledge, none have evaluated alternative measures of local segregation, such as evenness. Wong developed a local-level version of evenness that aims to capture the distribution of all racial and ethnic groups within an area to determine the diversity of each neighborhood (as compared to the metropolis as a whole) (2002). Just as Massey and Denton suggest that each of the different dimensions of segregation provides insight into the entire experience of segregated neighborhoods, the use of additional local measures in the context of segregation and health research may shed additional light on the relationship between neighborhood segregation and health.

Others have argued that measuring racial isolation is simply a proxy for the spatial concentration of poverty. While racial segregation and economic isolation are intertwined, racial isolation is likely a distinct form of neighborhood disadvantage that confers an additional risk for low birth weight outcomes (Debbink & Bader, 2011). As Massey and Denton have argued, without the framework of racial residential segregation, the changes in the structure of the US economy that led to the concentration of poverty would not have had such a massively destructive impact on urban Black neighborhoods (1993). This history may also be important for understanding the differences between African American, Hispanic, and Asian experiences of segregation. While the measurement may be the same, the meaning of segregation may be different for each community; we echo Grady and McLafferty's observation that the voluntary choice to reside in a so-called ethnic enclave (even if not particularly economically advantageous) as a means of accessing particular kinds of social support is fundamentally different from the involuntary constraints on opportunity and mobility that African Americans face in Black segregated neighborhoods (2007).

The literature on segregation and birth outcomes has also focused nearly exclusively on measuring results in terms of aggregate clinical outcomes such as low birth weight or weight in grams. Though useful for identifying mortality and morbidity risk, low birth weight is fundamentally a multi-faceted, relatively poorly understood biological phenomenon. However, research demonstrates that two related but distinct problems can result in low birth weight: intrauterine growth restriction and preterm delivery (Lu, Tache, Alexander, Kotelchuck, & Halfon, 2003; Paneth, 1995). First, intrauterine growth restriction results from an abnormally low fetal growth rate; at each gestational age, the fetus is smaller than would be expected because of some pathological constraint on its growth. Second, low birth weight can occur when infants who are otherwise growing appropriately are born prematurely. In these cases, the infant's low weight is a function of insufficient time in utero to achieve full growth potential.

Of course, infants can both have intrauterine growth restriction and be born preterm; however, it is worth nothing that research suggests that IUGR is itself a risk factor for preterm delivery (e.g., preterm labor may be triggered later in pregnancy by the same pathology which results in IUGR) (Romero et al., 2006; Zeitlin, Ancel, Saurel-Cubizolles, & Papiernik, 2000), and that the clinical management of prenatally-diagnosed IUGR includes induced early delivery (Grivell, Dodd, & Robinson, 2009). Taken together, these two findings suggest that if an IUGR infant is born preterm (whether spontaneously or via induction), IUGR is the driving pathological factor for the infant's low birth weight. Previous epidemiological research has often subdivided low birth weight outcomes into preterm delivery and small for gestational age term deliveries, but we believe this categorization preferences preterm delivery as an explanatory mechanism; based on the evidence, we propose instead to subdivide low birth weight births (i.e., those under 2500g) into small for gestational age (at any gestational age) vs appropriate for gestational age births. Because the clinical cut-off for intrauterine growth restriction is 2500 g at 37 weeks, any appropriate for gestational age infant that weighs less than 2500 g will necessarily also be preterm.

The distinction between intrauterine growth restriction and preterm delivery without intrauterine growth restriction is important for a number of reasons, not the least of which is that infants born small for gestational age have higher likelihood of neonatal death and perinatal morbidity (Bernstein, Horbar, Badger, Ohlsson, & Golan, 2000; Garite, Clark, & Thorp, 2004; Kady & Gardosi, 2004). In addition, the two processes have relatively distinct physiology and pathology: Preterm delivery is often associated with infectious and inflammatory processes (Romero et al., 2006, 2001), while the most clinically relevant driver of small for gestational age births is a structural problem with the placenta and blood supply to the fetus, which results in chronic insufficiency in the supply of oxygen and nutrients (Baschat & Hecher, 2004; Cox & Marton, 2009). Again, infants may be born both small for gestational age and preterm, but it appears that the uteroplacental dysfunction (e.g., vascular pathology) which can cause IUGR may also trigger preterm delivery (Baschat, 2010; Romero et al., 2006). Maternal stress is implicated in both types of low birth weight, as it can both increase vulnerability to infection and heighten the inflammatory response, and increase the likelihood of vascular pathology (Coussons-Read, Okun, & Nettles, 2007; Fiscella, 2004; Pearce et al., 2010). It is possible that the types and duration of stressors (e.g., acute vs. chronic) may matter for the development of spontaneous preterm delivery vs. intrauterine growth restriction.

Given that the two types of low birth weight – preterm delivery of an infant whose weight is appropriate for gestational age or delivery of a small for gestational infant – may arise from different physiological and pathological processes, it is reasonable to suspect that neighborhood circumstances (and, therefore, segregation) may be associated with one or the other process more closely. In fact, a closer association between segregation and either intrauterine growth restriction or preterm delivery without growth restriction may offer important insights regarding the ways in which neighborhood level stressors translate biologically into poor pregnancy outcomes. Furthermore, it could illuminate the types of interventions which might be most useful to mitigate these effects. Previous work has found that Black-White isolation measured on the local level is associated with small for gestational age low birth weight, but not with appropriate for gestational age preterm delivery (Debbink & Bader, 2011). However, no studies to date have explored this distinction and its association with segregation or other neighborhood factors for Hispanic or Asian mothers.

Why Los Angeles?

In this paper, we aim to explore whether local racial segregation – measured by either racial isolation or racial diversity at the census tract level – is associated with low birth weight in Los Angeles County. Using Census and vital statistics data, we will model the relationship between low birth weight and local segregation for each of three racial/ethnic minority groups, controlling for demographic and medical risk factors at the individual level (mother's age, nativity, parity, pregnancy complications, education, insurance, and prenatal care) as well as income at the neighborhood level.

Los Angeles County offers a unique opportunity to explore segregation among several racial groups; it has remained highly segregated, but is also a favored immigrant destination (Charles, 2009). As immigration begins to remodel America's cities in profound and important ways, Bobo and others have looked upon Los Angeles as a window into the future of the American metropolis (2000). Many urban centers are witnessing a demographic shift that will have important implications for understanding the relationship between neighborhood environments and health. Los Angeles finds itself at the forefront of America's changing demography, and studying this city may offer insight into the way our cities may look in the future. In particular, though racial diversity has increased, Zubrinsky Charles notes that Los Angeles' Black residents remain largely isolated from their White counterparts (2009). Increasingly, Hispanics and African Americans occupy the same geographic spaces within the city, but these remain largely separate from the areas in which Whites, and to some extent Asian Americans, live.

In this study, we contribute to the literature on low birth weight and segregation by leveraging the co-residence of multiple racial and ethnic groups in Los Angeles to address three main questions:

1) What is the relationship between local segregation (as measured by racial isolation) and low birth weight, independent of individual level predictors of low birth weight, for different race/ethnic groups?

2) What can alternative measures of local segregation (e.g., localized diversity) contribute to our understanding of the relationship between segregation and low birth weight in areas with multiple ethnic and racial groups?

3) What is the relationship between racial isolation and the two etiologies of low birth weight (appropriate for gestational age and small for gestational age low birth weight births) for different racial and ethnic groups?

In light of existing literature, we hypothesize that African American isolation from Whites will have an impact on low birth weight outcomes, and in particular may be associated with low birth weight via an increase likelihood of small for gestational age births. Higher diversity may be associated with lower odds of low birth weight for African Americans. On the other hand, we expect to find that racial isolation from Whites has a lesser impact, if any, on Hispanic and Asian American communities. For Hispanics and Asians, living in a more segregated/isolated ethnic area may be protective against low birth weight outcomes, especially for foreign-born mothers.

Methods

Data

Birth Data. Birth certificate data were obtained from the California Department of Public Health for Los Angeles County between 2000 and 2004. Los Angeles County was selected because it has multiple racial and ethnic groups with populations of sufficient size for analysis. In addition, Los Angeles County has a wide range of socioeconomic conditions within each racial and/or ethnic group, which may reduce the collinearity between racial segregation and the concentration of poverty. Finally, Los Angeles County is home to a larger proportion of people of color than Whites –

a so-called majority-minority area; it is possible that the meaning and consequences of racial segregation differ here from the northern, southern, and eastern geographical areas that have a larger proportion of White residents and have typically been the focus of segregation and birth outcomes research.

Due to population size limitations, the analysis was restricted to records for non-Hispanic Black, non-Hispanic White, Asian/Pacific Islander, and Hispanic mothers. This resulted in 746,934 singleton records where mother's city of residence was located within Los Angeles County, or county of delivery was reported as Los Angeles County, and which contained data for birth weight and mother's race data (10 records were missing birth weight or mother's race and were excluded). In addition, we excluded 12,968 infants with any congenital anomaly (trisomies, cleft palate, and congenital heart defect), since these genetic defects are commonly related to low birth weight and preterm delivery (Dolan et al., 2007; Honein et al., 2008; Khoury, Erickson, Cordero, & McCarthy, 1988). Descriptive statistics are reported for all of these records. Of these 733,966 births, records were also excluded from further analysis if they lacked Census tract identifiers or street addresses that could provide sufficient information to produce an accurate geo-code (N=14,226); there were no systematic differences in birth outcomes for these births compared to those with tract identifiers. An additional 2,270 records were excluded after geocoding because their Census tract or street address geocode was not within Los Angeles County. This resulted in 717,470 births to mothers of non-Hispanic Black, non-Hispanic White, Hispanic, or Asian/Pacific Islander race or ethnicity residing in one of the 2,052 populated Census tracts in Los Angeles County at the time of delivery.

Low birth weight. Low birth weight was defined as a categorical outcome of weight less than 2500g, regardless of gestational age. To examine the influence of residential segregation on different etiologies, we also subdivided all low birth weight births (i.e., those less than 2500g) into two mutually exclusive subcategories using standard clinical definitions (Gabbe et al., 2007): 1) small for gestational age; and 2) appropriate for gestational age (all infants in category 2 were born at <37 weeks gestation, and are thus accurately described as appropriate for gestational age preterm births). Standard definitions allow for infants over 2500g to be considered growth-restricted or preterm; however, we focus solely on births under 2500g because low birth weight contributes heavily to infant mortality and has known implications for longer-term morbidity (Baker, Olsen, & Sørensen, 2008; Hoyert, Freedman, Strobino, & Guyer, 2001; Mathews & MacDorman, 2007). Births under 2500g were classified as small for gestational age if an infant's birth weight was <10th percentile for their gestational age and sex (regardless of the number of weeks' gestation), a clinical cutoff derived from fetal growth curves (Alexander, Himes, R. B. Kaufman, Mor, & Kogan, 1996). Births under 2500g were defined as appropriate for gestational age if the infant's weight was greater than 10th percentile for gestational age and sex.

While the use of a categorical outcome, as opposed to continuous birth weight in grams, significantly diminishes the amount of information contained in the outcome variable, we deemed this appropriate for several reasons. Preliminary analyses suggested that the variation between neighborhoods using weight in grams was relatively small, but the burden of low birth weight (e.g., low birth weight rate) showed more variation between neighborhoods. In addition, though low birth weight seems to be an arbitrary clinical cutoff, it does have clinical importance in that increases in weight for those infants weighing less than 2500 grams are associated with more substantial improvement in outcomes than for those infants weighing less than 2500g (Sastry & Hussey, 2002). Therefore, assessing the burden of low birth weight by neighborhood is a valid public health and clinical exercise.

Individual Characteristics. Birth certificate data included infant sex, gestational age (as determined by mother's last menstrual period), and congenital conditions; and mother's age, race, education, insurance status, parity, pregnancy co-morbidities, month of prenatal care initiation, and number of prenatal care visits. We coded mother's race as non-Hispanic White, non-Hispanic Black, Asian/Pacific Islander, Hispanic, and other (including mothers who chose multiple race categories). We included mother's age as both a continuous variable and a quadratic term; age was mean centered. Mother's education was used as a mean-centered discrete continuous variable, with missing education re-coded to zero; categorical analyses using missing education as a separate category indicated little difference between this group and those mothers reporting no education (coded originally as 0).

Vital records also included medical history and visit data for the pregnancy, including parity, which we recoded to nulliparous vs. multiparous. Complications of pregnancy were recoded to a count variable indicating the number of complications, which was mean-centered; a dummy variable indicating the presence of any complication was also tested. Though pregnancy complication data are of questionable reliability, aggregating the data may provide improved reliability as to the existence of any complication (as opposed to the use of specific diagnoses or complications in analyses). Insurance types included MediCal (California Medicaid), private payers (including Blue Cross/Blue Shield plans and HMO/capitated plans), other government payers (including Champus/Tri-care (active duty military and dependents), Veteran's Administration, Medicare, and Indian Health Service), self-pay, and no or unknown coverage. We include prenatal care insurance type because it is likely to represent latent income and employment disparities between African American and Hispanic mothers on the one hand, and White and Asian/Pacific Islander mothers on the other (Grady, 2006).

Gestational age, initiation of prenatal care, and number of prenatal care visits were combined to create scores for the adequacy of prenatal care utilization (APNCU) index (Kotelchuck, 1994). The index is scored according to initiation of prenatal care (first trimester vs. any other time) and the proportion of visits received compared to the number of visits recommended by the American College of Obstetricians and Gynecologists (ACOG) for the given gestational age at delivery (i.e., given the duration of pregnancy at delivery, the expected number of visits if the ACOG guidelines were followed precisely) (American Academy of Pediatrics & American College of Obstetricians and Gynecologists, 2007). If a woman receives no prenatal care, or if prenatal care begins later than the 4th month of pregnancy, care is described as "inadequate." Inadequate prenatal care also includes women whose care began in the first trimester, but who had fewer than 50% of the recommended number of visits for the given duration of pregnancy. "Intermediate" prenatal care includes any woman whose prenatal care began in the first trimester, but who had only 50-80% of the recommended visits relative to gestational age. "Adequate" prenatal care describes those women whose care began in the first trimester and had 80-110% of the recommended visits relative to duration of pregnancy. Finally, "adequate plus" care characterizes those pregnancies for which care began in the first trimester and for which the proportion of recommended vs. observed visits exceeds 110%. Though birth certificate reliability and validity is questionable, especially for prenatal care utilization, the birth certificate provides a more reliable source of prenatal care utilization when compared to surveys of providers or mothers (Penrod & Lantz, 2000).

All analyses were originally adjusted for year and season of birth using fixed effects, but there was no significant effect from these adjustments. Reported analyses are also adjusted for geocoding accuracy and a best-approximation for gestational age accuracy (e.g., late entry to prenatal care).

Census Data. Census-tract level variables for each of the 2,054 Census tracts in Los Angeles County were obtained from Summary File 3 of the 2000 Census. Total (Black, White, Hispanic, and Asian/Pacific Islander) population and individual race/ethnic group populations per tract were used to calculate local racial segregation scores on isolation and diversity for each tract. In addition, the percentage of residents in poverty was used to create a spatial concentration of poverty measure following the same procedure as that for racial isolation. Additional variables were used to create mean scales for various tract measures (described below).

Segregation Indices. The multi-ethnic makeup of Los Angeles County required the use of several segregation scores to fully characterize each neighborhood. Most segregation indices focus on only two ethnic or racial groups; we used one of these measures, developed by Krivo et al., to create an intergroup segregation score for each pair of racial and ethnic groups in the study population (e.g., Black-White, Black-Hispanic, Black-Asian/Pacific Islander, etc.) (Krivo, Byron, Calder, & Kwan, 2007). The Krivo index (*LS*) provides a neighborhood-specific measure of the probability of interaction between individuals in two groups compared to what would be expected in the metropolitan area as a whole if residents were not spatially clustered within tracts (Krivo et al., 2007; Massey & Denton, 1988, 1989; Wong, 2002). Such local measures provide a better approximation of isolation than simply using neighborhood racial or economic composition because they position each areal unit within the context of neighboring areal units (Diez Roux, 2007).

The local isolation measure is calculated as:

$$LS_{i*xy} = 1 - \frac{(\sum_j c_{ij} y_j)/(\sum_j c_{ij}(x_j + y_j))}{(\sum_j y_j)/(\sum_j (x_j + y_j))}$$

where *x* and *y* represent the number of people in group X and Y, respectively (i.e., Blacks and Whites or Hispanics and Asians), that live in census tracts *i* and *j*; *cij* is the value of cell *ij* in a spatial weights matrix, and is equal to 1 if tracts *i* and *j* share a border or if *i=j* (the neighborhood itself) and zero otherwise. Positive values of this index are bounded between 0 and 1 and represent a proportionate decrease of the chance of interaction of group X with group Y compared to the probability of random interaction in the region as a whole. For each race/ethnic group dyad, the score was calculated once with the first group as the reference group, and once with the second group as the referent (i.e., White-Black isolation and Black-White isolation were calculated separately).

Categorical measures were created from the continuous segregation scores. Theoretical and empirical work suggests that a score of 0.60 or greater indicates hypersegregation, so we utilized this cut-off to characterize isolation of one group from each of the other racial and ethnic groups (Massey & Denton, 1988, 1989).

We also utilized a second segregation index, Wong's spatial entropy (i.e., spatial diversity) measure, *H*, to attempt to capture multi-ethnic co-occupancy of Census tracts. Based upon the metropolitan-level entropy concept, this index describes the mixture of individuals of different ethnic groups living within the same areal unit and adjacent units (Wong, 2002). The spatial diversity (*H*) of areal unit *i* is measured as:

$$H_i = -\sum_{x}^{n}\left[(\sum_{j}^{m} c_{ij}(P_{jx}) / \sum_{j}^{m} c_{ij}(P_j)) * \ln(\sum_{j}^{m} c_{ij}(P_{jx}) / \sum_{j}^{m} c_{ij}(P_j))\right]$$

where *i* and *j* represent areal units and *m* represents the total number of units in the metropolitan area. As in the Krivo equation, the *c* term represents the value of a spatial matrix indicating the adjacency of units *i* and *j*. The first term represents the ratio of persons of group X in areal unit *j* to the total population of persons, P, in areal unit *j*, summed over all *j* neighbors of *i* (including *i* itself). X represents any one racial or ethnic group out of the total of all racial or ethnic groups, *n*.

The value is standardized to the ln(*n*), or the maximum possible entropy, creating an index with a value between 0 and 1. A high value on this scale represents high levels of diversity, or low levels of segregation. We created a three-category variable using the top and bottom deciles of *H*; values greater than or equal to 0.80 were considered high diversity areas, and those with scores less than 0.30 were considered low diversity areas.

In the case of both the Krivo and Wong segregation measures, we defined adjacency with a first order queen contiguity spatial weights matrix, which indicates those Census tracts that share either a border or a vertex with a 1 and those which do not share any boundaries with a 0.

Census Scales. In order to try to understand the impact of potential neighborhood contributors to low birth weight, standardized mean scales measuring each tract's level of residential turnover, women's educational and employment opportunities, and proportion of foreign-born and non-English speaking residents were created. Both theoretical and empirical considerations drove the creation of the scales. Residential turnover, which is representative of structural instability, was operationalized using a scale that combined the logged proportion of residents who had not moved in the last 5 years, the logged proportion of owner-occupied housing, and the logged proportion of multi-dweller units. Chronbach's alpha for this scale was 0.85, and average interitem correlation was 0.66. Women's disadvantage, which represents the personal opportunity structure for the average woman in a tract, was composed from logged versions of the proportions of unemployed women, college educated women (greater than 1 year of college), women with professional or managerial occupations, female-headed households, and residents receiving public assistance. Chronbach's alpha for this scale was 0.91, and the average interitem correlation was 0.68. Finally, immigrant neighborhood was operationalized by a mean scale of logged versions of: proportion of foreign born residents, non-citizens, non-English speakers, English speakers (reverse coded), and people who speak English very well (reverse coded). Chronbach's alpha for this scale was 0.89, and the average interitem correlation was 0.62.

Each of the scales were standardized and mean-centered in the analyses. The scale creation was conducted using the entire sample of 2,041neighborhoods. Though the scale scores were standardized, because not all tracts are included in the stratified analyses, the mean is close to but not exactly 0 when considering tracts for analysis in just one racial or ethnic group.

<u>Mapping</u>

We used ArcMap 9.3.1 to produce visualizations of LA County birth outcomes, segregation statistics, and neighborhood characteristics as obtained from Census 2000 data (ESRI, 2009). In particular, descriptive analysis of the spatial clustering of low birth weights was produced using ArcMap's implementation of the Getis-Ord *Gi** spatial "hot spots" statistic. Getis-Ord *Gi** is a spatial autocorrelation z-statistic describing the difference between the observed occurrence of an event in a given spatial unit and its neighbors and the expected occurrence of that event based upon the average occurrence in the entire area in question (Getis & Ord, 1996). Because it is a z-score, no further calculations are needed to assess the null hypothesis that the event or attribute is not spatially clustered; *Gi** scores larger than 1.96 or smaller than -1.96 (e.g., $p < .05$) represent statistically significant clustering.

<u>Statistical Models</u>

In order to assess the impact of various intergroup racial/ethnic isolation measures, we stratified our analyses by mother's race/ethnicity. While this approach precludes direct comparisons of the effects between racial and ethnic groups, it provides clarity of interpretation because it does not require multiple cross-level interaction effects in order to lift the constraint that all other covariates in the model have the same impact across racial groups (Sastry and Hussey 2002). We assessed the association between individual and neighborhood level variables by fitting a series of two-level hierarchical generalized linear models with a logit link function (Bernoulli models) (Raudenbush and Bryk 2002). For each racial/ethnic group, we first fit an unconditional model to determine the baseline variance in low birth weight at the neighborhood level, which allows the estimation of the proportion of variance explained by the addition of covariates. Subsequent models (i.e., intercepts-as-outcomes) were then used to measure the association between neighborhood (level 2) predictors and low birth weight independent of the individual factors. Equations 1a & 1b show the model used; Equation 1a is the individual-level model, and Equation group 1b is the Census-tract level model.

$$\eta_{ij} = \beta_{0j} + \beta_{1j}(X_1)_{ij} + \beta_{2j}(X_2)_{ij} \ldots + \beta_{nj}(X_n)_{ij} \qquad \text{(Equation 1a)}$$

$$\left\{ \begin{array}{l} \beta_{0j} = \gamma_{00} + \gamma_{01}(W_1) + \gamma_{02}(W_2) \ldots + \gamma_{0n}(W_n) + u_{0j} \\ \beta_{nj} = \gamma_{nj} \end{array} \right\} \qquad \text{(Equation group 1b)}$$

where η_{ij} is the log of the odds of low birth weight, β_{0j} is the individual level intercept, and γ_{00} is the average log-odds of low birth weight across Census tracts. *X* represents the individual level covariates, and *W* are the level-2 covariates. The random effect at the neighborhood level is specified by u_{0j}. Note that for the unconditional model, neither *X* nor *W* is included, and, therefore, the model includes only β_{0j} at level 1 and $\gamma_{00} + u_{0j}$ at level 2. For intercepts-as-outcomes models, $\beta_{nj} = \gamma_{nj}$ for all $n>0$; that is, the level-2 equation with random effects applies only to the intercept, and the coefficients of all other level-1 covariates are fixed.

Because previous research has suggested that nativity may play an important role in the association of neighborhood characteristics like segregation (Osypuk et al. 2010) or income and proportion foreign born (Finch et al. 2007), we next fit a cross-level interaction model for Asian/Pacific Islander and Hispanic mothers in which the coefficients for neighborhood-level covariates are allowed to vary by mother's nativity (the small population of foreign-born Black women did not permit us to model this interaction in the population of Black mothers). Equation group 2 provides the cross-level models where X_1 (*ForBor*) is the variable for foreign born:

$$
\begin{aligned}
\eta_{ij} &= \beta_{0j} + \beta_{1j}(ForBor) + \beta_{2j}(X_2)\ldots + \beta_{nj}(X_n) \\
\beta_{0j} &= \gamma_{00} + \gamma_{01}(W_1) + \gamma_{02}(W_2)\ldots + \gamma_{0n}(W_n) + u_{0j} \\
\beta_{1j} &= \gamma_{10} + \gamma_{11}(W_1) + \gamma_{12}(W_2)\ldots + \gamma_{1n}(W_n) \\
\beta_{nj} &= \gamma_{nj}
\end{aligned}
\qquad \text{(Equation group 2)}
$$

Finally, we examined the risk of small for gestational age low birth weight as compared to appropriate for gestational age (preterm) low birth weight. We fit a multinomial logistic hierarchical generalized linear model, treating normal birth weight (reference), low birth weight due to early delivery of an appropriate for gestational age, early infant, and low birth weight due to intrauterine growth restriction as competing risks. The multinomial logit link function for a 3-response outcome can be written:

$$\eta_{mij} = \log\left(\frac{\varphi_{mij}}{\varphi_{Mij}}\right) = \log\left(\frac{P(R_{ij} = m)}{P(R_{ij} = M)}\right) \qquad \text{(Equation 3)}$$

where η_{mij} represents the log-odds of the response, *R,* being in category *m* as compared to category *M*. The base category, or *M*, is the reference category. Equations for the models mirror those in Equation group 1, except that with 3 outcomes, we have a pair of level-1 equations (one for each possible response other than the reference), and two sets of level-2 equations (one to go with each of the level-1 equations). HLM version 6.06 (SSI, Lincolnwood, IL) was used to predict the HGLM models.

Results

<u>Population Characteristics</u>

Birth Outcomes. In Los Angeles County from 2000-2004, approximately 5% of infants weighed less than 2500 g; nationally, the figure is 6-7% for the same time frame. Table 2-1 provides the characteristics of the population broken down by racial/ethnic group. Though low birth weight rates for each racial/ethnic group are lower than national averages for each group, African American women shoulder a disproportionate burden of low birth weight in Los Angeles County. Among Black women, the low birth weight rate is 91 per 1000 births, while it is under 50 per 1000 for all other groups. The distribution of small for gestational age and appropriate for gestational age low birth weight births is approximately equal across groups, with a greater proportion of low birth weight resulting from small for gestational age births.

Mother's Sociodemographic Characteristics. Maternal age averages 28 years, with Hispanic women and Black women having lower average ages. During the 5 years of this study, 62.87% of LA County births were to Hispanic women; of these, nearly 68% of the mothers were born outside the US. The figures are 10.3% and 87.8%, respectively, for Asian/Pacific Islander women. Clear disparities in maternal education levels exist, with nearly 50% of White and Asian/Pacific Islander mothers having 4 or more years of college, while Hispanic and Black mothers have lower educational attainment on average. Nearly 50% of African American mothers received prenatal care insurance through MediCal (California's Medicaid) program; over 65% of Hispanic women were similarly insured. In contrast, Whites and Asian/Pacific Islanders were insured through the private market 82% and 67% of the time, respectively.

Health Status and Access. Percentage of complications represents the proportion of mothers in each group for whom at least one complication of pregnancy was reported, including pre-existing chronic disease (e.g. asthma), pregnancy-induced disease (e.g., gestational diabetes), and reproductive history (e.g., previous high-risk pregnancy or cervical cerclage). African Americans and Whites have the highest reported rates of complications. African Americans and Hispanic women are most likely to have inadequate prenatal care as defined by the Adequacy of Prenatal Care Utilization Index. In keeping with the higher complication rate, White mothers and African American mothers are most likely to be classified in the Adequate Plus category, which often indicates a high-risk pregnancy requiring extra visits beyond what would normally be recommended.

Neighborhood Characteristics. The bottom half of Table 2-1 gives the percentages of each type of neighborhood within each racial or ethnic category. The 2,041 included Census tracts had an average proportion of residents in poverty of 17.98%. The residential turnover scale ranged from -6.73 to 1.31 (mean = 0, SD = 0.88). Women's disadvantage scores had a minimum of -2.33 and a maximum of 3.15 (mean = 0, SD = 0.86). Finally, immigrant neighborhood characteristics had a minimum of -2.72 and a maximum of 3.23 (mean = 0, SD = 0.83). Because models were stratified, the number of Census tracts included in the models varies for each group (Census tracts with fewer than 2 births for any one racial group were excluded from analysis for that group). Black mothers (n = 54,098) lived in 1,806 of the 2,054 Census tracts; approximately 15% of these were classified as Black-White isolated, fewer than 2% Black-Hispanic isolated, and approximately 18% Black-Asian/Pacific Islander isolated. Black-White and Black-Asian/Pacific Islander isolation were highly correlated, and Black-Asian isolation was subsequently dropped from regression models to avoid inflating the coefficient on Black-White isolation. The average proportion of residents living in poverty was 17.98%. Ranges on the three Census scales were similar to the overall range.

Nearly all Census tracts (2,027) were included in the stratified analysis for births to Hispanic mothers (n = 452,753). Hispanic-White isolation characterized 32% of these neighborhoods, Hispanic-Black isolation, 33%, and Hispanic-Asian isolation, 27%. Average poverty was 17.96%. Census scales were similar in range to those of the overall population. Asian and Pacific Islander mothers (n= 74,242) resided in 1,926 Census tracts, of which approximately 9% were classified as Asian-White isolated, 32% Asian-Black isolated, and 5% Asian-Hispanic isolated. Average poverty was 17.38%. Again, the range on the three neighborhood scales was similar to that of the overall population, though Asian/Pacific Islander mothers had less exposure to highly stable residential areas (the lower end of the range was not as negative as that for the overall population or either Hispanic or Black women's neighborhoods).

Figure 2-1 provides a map of Los Angeles county tracts with a graded color scheme indicating the tracts in which mothers of one racial or ethnic group make up 50% or more of the total births; African Americans are represented in blue, Hispanics in green, Asian/Pacific Islanders in red, and Whites in yellow. Tracts without a majority of mothers from one racial or ethnic group are White. The clustering of higher proportions of mothers of the same race is readily apparent, with swaths of tracts having no majority race or ethnic group creating seams between areas of racial or ethnic majority. Higher proportions of Black mothers are centered on the traditional Black neighborhood of Inglewood, while Hispanics are heavily represented in the rest of the east and south downtown areas, as well as in the San Fernando Valley to the northwest. Whites are a majority in the Beverly Hills and Malibu areas, as well as in the more suburban areas of the county outside of Santa Clarita and Palmdale. Asian and Pacific Islander mothers are largely centered in the northeast and east of the city, with prominent clusters near Alhambra (north) and Diamond Bar/Rowland Heights (east); a smaller cluster of tracts with large proportions of Asian/Pacific Islander mothers occurs north of Long Beach near Artesia.

Figure 2-2, Panel A shows the results of the spatial clustering of low birth weight events (the absolute number of low birth weights per tract). Tracts with z-scores above 1.96 are in orange and dark red, while those with z-scores less than -1.96 are in medium and dark blue. Tracts with z-scores in the mid range are lightly colored or colorless. This map shows that the prevalence of low birth weight is spatially clustered, with prominent clustering in the south central portions of the county and a few additional clusters in the northeast portions of the county. These clusters encompass tracts with high proportion African American, Hispanic and Asian/Pacific Islander mothers. Notably, the tracts with the lowest Z-scores are similar to areas of high proportions of White mothers. Figure 2-2, Panel B shows the results of the spatial clustering low birth weight rates (the number of low birth weights as a fraction of the number of births per tract). Tracts are colored using the same scheme, and it is notable that the areas of highest clustering are now very closely aligned with areas with high proportion Black mothers (and with tracts that scored highly on Black-White isolation).

Table 2-2a provides distributions of the 2,041 tracts with greater than 2 births (and sufficient Census information) by racial isolation categories (e.g., scoring >0.60 on Black-White, Hispanic-White, and Asian-White isolation) and poverty status (>30% of residents in poverty). Within each racial isolation group, tracts that are isolated from Whites also have a higher proportion of tracts with >30% of residents in poverty (e.g., 14% of Black-White isolated tracts have high poverty vs just under 2.5% of Black-White non-isolated tracts). Overall, approximately 4% (n=81) tracts are poor, 13.3% (n=271) are Black-White isolated, 31.4% (n=640) are Hispanic-White isolated, and 8.8% are Asian-White isolated (n=180). Table 2-2b shows the number and rate of low birth weight for each of the types of tract. Each of the racially isolated (as it pertains to Whites) neighborhood types has an increased rate of low birth weight, as do neighborhoods with higher levels of poverty. Figure 2-3 provides a graphical display of the relationships between neighborhood racial isolation measures, neighborhood poverty, and the rate of low birth weight. Notably, the rate of low birth weight is highest in Black-White isolated, non-poor neighborhoods (5.93%). Poor, Asian-White non-isolated tracts and Black-White isolated poor tracts have the next highest rates of low birth weight. It is clear that for neighborhoods that are not isolated from Whites, rates of low birth weight are higher in poorer tracts; on the other hand, in tracts isolated from Whites, the gap between poor and non-poor tracts is much smaller within each racial group.

Individual Factors

Tables 2-3, 2-4, & 2-5 provide results for the stratified models (African American, Hispanic, and Asian/Pacific Islander, respectively) of individual and tract-level predictors of low birth weight, including local racial isolation. In each of the 3 tables, Model 1 shows the association of individual-level predictors with the odds of low birth weight. The models show strikingly similar relative importance of individual factors across racial groups, and many coefficients are in the expected direction. Having a male infant reduces the odds of low birth weight birth, while increasing maternal age increases the odds of low birth weight birth. Being born outside the US is protective for infants of Hispanic mothers (OR = 0.875, 95% CI 0.843, 0.907), but not for Asian/Pacific Islander mothers. Education is protective for mothers in all groups, though the relative reduction in the odds of low birth weight is higher for African American mothers than for either Hispanics of Asian/Pacific Islanders (ranging from 2-10% reduction in odds of low birth weight for each year of education above the mean for each racial group). First birth (nulliparity) is associated with an increase in the odds of low birth weight in each of the racial and ethnic groups, and increasing numbers of pregnancy complications are also associated with increases in the odds of low birth weight for all groups.

For both Hispanic and African American mothers, Medicaid, self-paid prenatal care, and no prenatal care insurance coverage are associated with increased odds of low birth weight as compared to private payer insurance. Asian/Pacific Islander mothers' odds of low birth weight are only associated with Medicaid or lack of insurance; self-paid insurance status has no association with low birth weight odds. Other government payers are associated with decreased odds of low birth weight for African Americans, and increased odds of low birth weight for Hispanics, but there is no association for Asian/Pacific Islander mothers. Finally, for all racial and ethnic groups, both inadequate and adequate plus care, as defined by the Kotelchuck index of prenatal care utilization, are associated with increased odds of low birth weight (in comparison to adequate prenatal care utilization). Interestingly, because these models also control for late entry into prenatal care as a proxy for gestational age reliability, the coefficient for inadequate prenatal care is driven by women whose care began in the first trimester but who had fewer than 50% of the recommended prenatal visits by the time of delivery. Intermediate care was not associated with the odds of low birth weight for any of the racial/ethnic groups.

Racial Isolation

The remaining models in Tables 2-3, 2-4, and 2-5 show the results of the HGLM models with tract-level and individual-level factors predicting low birth weight by mother's race/ethnicity.

Table 2-3 shows the results of models predicting the probability of low birth weight among Black mothers. In model 2, racial isolation measures are included in addition to individual level factors. As noted earlier, Black-Asian isolation was dropped from the HGLM models due to collinearity with Black-White isolation. Model 2 shows that Black-White isolation is associated with a 15.8% increase in the odds of low birth weight (OR = 1.158, 95% CI = 1.071,1.253). Isolation of Blacks from Hispanics has no significant association with the odds of low birth weight. In model 3, we substitute the tract proportion of residents in poverty for the racial isolation measures. In this model, we see a significantly positive association between increasing percentage of residents in poverty and odds of low birth weight. Each standard deviation increase from the mean proportion in poverty (mean ln(poverty) = 2.69, SD = 0.75) results in a 2.9% increase in the relative odds of low birth weight (OR = 1.092, 95% CI = 1.022,1.166)[1]. Model 4 includes both the segregation scores and the tract proportion in poverty. This model shows a decrease in the strength of the association between Black-White isolation and the odds of low birth weight birth (OR = 1.132, 95% CI = 1.038,1.235); the predicted increased odds of low birth weight as a function of percent in poverty for the tract is also reduced (OR = 1.045, 95% CI = 0.971,1.126). Model 5 shows the fully-specified model including measures of racial isolation, proportion in poverty, residential turnover, women's disadvantage, and immigrant neighborhood. Only Black-White local racial isolation and immigrant neighborhood status are significantly associated with low birth weight outcomes, with living in a racially isolated tract predicting a 12.8% increase in the odds of low birth weight (OR = 1.128, 95% CI = 1.020,1.247), and living in an immigrant neighborhood predicting an 2.7% increase in the odds of low birth weight for each standard deviation increase in the immigrant neighborhood scale (OR = 1.081, 95% CI = 1.003,1.164). In a stepped analysis of the Census scales and segregation scores (that is, models testing each scale independently), results were similar; of the three scales,

1) Relative odds for continuous variables without obvious units of change are determined by the product of the standard deviation of the variable and the regression coefficient on the variable, which is then exponentiated to produce the change in relative odds for a one standard deviation change in the variable.

only increased score on the immigrant neighborhood scale predicted increased odds of low birth weight.

The neighborhood level variance in the unconditional model (random effect at the neighborhood level with no other covariates) was 0.052; adding individual level variables to the model increased the neighborhood variance to 0.067. Though counterintuitive, this is not an uncommon result. The inclusion of individual level variables controls for heterogeneity in individuals at the tract level, which can unmask variance between neighborhoods, leading to an increase in tau (neighborhood level variance). The subsequent inclusion of neighborhood-level predictors then reduces the neighborhood level variance. In this case, when compared to the neighborhood variance of Model 1, the fully specified model (Model 5) explains just over 15% of the variation in the odds of low birth weight between neighborhoods where African American mothers reside.

Table 2-4 shows the results of similar models for Hispanic mothers in LA County. Model 2 shows the association between the three isolation scores and the odds of low birth weight for Hispanic women. Hispanic-White isolation is positively associated with the odds of low birth weight, predicting a nearly 18% increase (OR = 1.177, 95% CI = 1.128,1.229). Hispanic-Black isolation also predicts an increase in the odds of low birth weigh (OR = 1.063, 95% CI = 1.026,1.102), while Hispanic-Asian isolation is not associated with low birth weight among Hispanic women. Model 3 substitutes the spatial isolation measures with the percentage in poverty in the tract. As for African Americans, the proportion of residents living in poverty predicts an increase in the odds of low birth weight among Hispanic mothers; in this case the change in relative odds is 3% for each standard deviation change in logged proportion in poverty (OR = 1.094, 95% CI = 1.058,1.131). In Model 4, both the proportion of residents in poverty and local racial isolation are included; as with the models for African American mothers, the inclusion of all measures attenuates each of the positive association with low birth weight. However, both Hispanic-White isolation and Hispanic-Black isolation remain significantly associated with increased odds of low birth weight of 15.7% and 6.8%, respectively (OR = 1.157, 95% CI = 1.104,1.212; OR = 1.068, 95% CI = 1.030,1.107, respectively). However, percent in poverty is not significantly associated with birth outcomes in this model. In the fully-specified model (model 5), only Hispanic-White isolation and immigrant neighborhoods remain positively associated with the odds of low birth weight. Hispanic-White isolation predicts a 12.3% increase in the odds of low birth weight (OR = 1.123, 95%CI = 1.069,1.181), while increasing immigrant neighborhood characteristics predict a 3% increase in the relative odds of low birth weight for every standard deviation increase in the neighborhood scales measures (OR = 1.06, 95 % CI = 1.022,1.106). This model suggests that residence in immigrant neighborhoods can explain and/or mitigate both the association between Hispanic-Black isolation and low birth weight; in stepped models (not shown), both immigrant neighborhood and women's disadvantage were independently associated with low birth weight outcomes. As with the models for African American mothers, controlling for individual level risk factors increased the variance at the neighborhood level. The fully specified model again accounts for approximately 15% of the neighborhood level variance in Model 1.

Table 2-5 details the results for the third set of similar models for Asian/Pacific Islander mothers. In model 2, neither Asian-White nor Asian-Black isolation is associated with the odds of low birth weight; Asian-Hispanic isolation, however, is protective against low birth weight, and predicts a 17% decrease in the odds of low birth weight (OR = 0.833, 95% CI = 0.720,0.964). In model 3, each standard deviation change from the mean percentage of residents in poverty is associated with a relative odds of low birth weight of 1.02, or 2.4% change in the odds of low birth weight (OR = 1.075, 95% CI = 1.012,1.141). With both racial isolation measures and the percentage of residents in poverty as covariates (Model 4), only Asian-Hispanic isolation remains significantly negatively associated with odds of low birth weight (OR = 0.856, 95% CI = 0.738,0.994). In the final model, women's disadvantage at the neighborhood level is associated with increased odds of low birth weight (OR = 1.153, 95% CI = 1.041,1.277); an increase on this scale of one standard deviation translates to a relative odds of low birth weight of 1.1 (or a 10% change in the odds for each standard deviation change in women's disadvantage). In addition, the association between Asian-Hispanic isolation remains significant, predicting approximately 15%

decrease in the odds of low birth weight (OR = 0.848, 95% CI = 0.728,0.987). In stepped models not shown, both women's disadvantage and immigrant neighborhood were independently associated with low birth weight outcomes. The fully-specified model explains 35.7% of the neighborhood level variance in the odds of low birth weight; approximately 29.4% is explained by individual level variables, and an additional 6.33% is explained by the neighborhood level variables.

Racial Diversity

Models in Tables 2-6, 2-7, and 2-8 mirror those in the tables noted above, except for the inclusion of local racial diversity rather than local racial isolation to capture a different dimension of local racial segregation. Due to the repetitive nature of describing each model in series, we provide an overview of the results of these models with an eye toward the relative importance of neighborhood covariates.

Table 2-6 provides the results of these models for Black mothers. The striking result is that neither high diversity (top decile of spatial racial diversity) nor low diversity (bottom decile of spatial racial diversity) has an association with low birth weight outcomes among Black mothers in any of the models. Higher proportion of residents in poverty, however, predicts an increase in the odds of low birth weight (ORs from 1.082-1.154) in all models with the exception of the fully-specified model (model 5). In this final model, only residential turnover has a significant relationship with the odds of low birth weight for African American women; a one standard deviation increase in residential turnover is associated with a 2% increase in the relative odds of low birth weight (OR = 1.062, 95% CI = 1.004,1.122). In stepped models not shown, residential turnover and neighborhood level disadvantage for women predicted an increase in the odds of low birth weight for Black mothers.

In Table 2-7, we model the relationship between racial diversity and low birth weight for Hispanic mothers. Again, we find that neither high nor low diversity predicts a difference in the odds of low birth weight for Hispanic women, with the exception of a positive association between low diversity and higher odds of low birth weight in Model 2, which is not adjusted for any additional covariates. Once other covariates are included, the apparent association between low diversity and increased odds of low birth weight is eliminated. In these models, higher proportion of residents in poverty is associated with increased odds of low birth weight in models that do not also include women's disadvantage or immigrant neighborhood scales. In the final model, each of the Census scales is associated with increased odds of low birth weight for Hispanic mothers; one unit increase in residential turnover predicts 1.4% increase in low birth weight (OR = 1.039, 95% CI = 1.010,1.069); one standard deviation increase in women's disadvantage at the neighborhood level predicts 3.1% increase in the odds of low birth weight (OR = 1.085, 95% CI = 1.031,1.142); and one standard deviation increase in immigrant neighborhood status predicts 4.0% increase in the odds of low birth weight (OR = 1.115, 95% CI = 1.078,1.153).

In Table 2-8, the results for models estimating the association between racial diversity and low birth weight outcomes for Asian/Pacific Islander women are provided. In contrast to the models in Tables 2-6 and 2-7, racial diversity – specifically, high racial diversity – has a consistent, positive association with increased odds of low birth weight for Asian/Pacific Islander women. The OR ranges from 1.099 to 1.117, indicating that compared to tracts in the middle 80% of the range of diversity scores, higher diversity contributes a 9.9% to 11.7% increase in the odds of low birth weight for Asian/Pacific Islander women. Higher proportion of residents in poverty is also significantly associated with increased odds of low birth weight in models that do not include the Census neighborhood scales. Of the Census scales, only neighborhood level of women's disadvantage shows a significant relationship with increased odds of low birth weight among Asian/Pacific Islander women; in model 5, this translates to an increase in the odds of 5% (relative odds of 1.05) for each standard deviation change in women's disadvantage (OR = 1.157, 95% CI = 1.047,1.279). Women's disadvantage and high diversity are the only significant neighborhood factors associated with the probability of low birth weight.

Racial Isolation and Diversity – Comparison Models

Tables 2-9, 2-10, and 2-11 illustrate the differences between measuring segregation via isolation and diversity and low birth weight outcomes for each racial/ethnic group under study. Model 1 in each table is identical to the fully-specified model (Tables 2-3 through 2-5, Model 5) incorporating racial isolation as the segregation measure. Model 2 for each table is identical to the fully-specified model (Tables 2-6 through 2-8, Model 5) which uses racial diversity as the segregation measure. Model 3 incorporates both racial isolation and racial diversity measures in the same model. Table 2-9 provides the results of these models for African American women. The inclusion of both high diversity and Black-White racial isolation in the same model results in a larger coefficient on Black-White isolation and a significant and increased coefficient on high diversity – both of which are associated with increased odds of low birth weight. High diversity predicts at 15.4% increase in the odds of low birth weight, while Black-White racial isolation predicts a 17.3% increase (OR = 1.154, 95% CI = 1.040,1.281; OR = 1.173, 95% CI = 1.058,1.300). Of the Census scales, only living in an immigrant neighborhood is associated with an increase in the odds of low birth weight (OR = 1.095, 95% CI = 1.015,1.180).

In Table 2-10, we provide results from these models for the population of Hispanic mothers. Results mirror those for African American mothers: including both diversity and isolation measures increases coefficient size for Hispanic-White isolation and results in a significant positive association between high diversity and the odds of low birth weight (OR = 1.154, 95% CI = 1.097,1.214; OR = 1.117, 95% CI = 1.047,1.191). In addition, low diversity in this model is significantly associated with a decrease in the odds of low birth weight (OR = 0.917, 95% CI = 0.867,0.969). Residence in an immigrant neighborhood also predicts a 2.6% increase in the odds of low birth weight for each standard deviation increase (OR = 1.072, 95% CI = 1.030,1.116).

Table 2-11 contains the results for these models for Asian/Pacific Islander mothers. In contrast to the results for Hispanic or African American women, the coefficients and significance measures change very little between models including either diversity or isolation and the model that includes both measures. Asian-Hispanic isolation remains protective, predicting approximately

15% decrease in the odds of low birth weight (OR = 0.857, 95% CI = 0.735,0.998). High diversity is associated with increased odds of low birth weight (OR = 1.104, 95% CI = 1.004,1.214). Women's disadvantage at the neighborhood level is also associated with increased odds of low birth weight (OR = 1.156, 95% CI = 1.044,1.281).

Foreign-born vs. US-born Hispanic and Asian/Pacific Islander Mothers

Table 2-12 provides results of the cross-level interaction on mother's nativity for Asian/Pacific Islander and Hispanic mothers (the population of foreign-born Blacks was far too low to make a similar comparison). Models 1 & 2 depict results for US-born and foreign-born Asian/Pacific Islander mothers, respectively. As noted earlier, foreign nativity did not have any significant association with birth outcomes for Asian/Pacific Islanders; as such, the findings from this cross-level model suggesting little or no difference between them do not come as a surprise. The results from this model show no significant associations between neighborhood-level variables and birth outcomes for Asian/Pacific Islander women, irrespective of nativity.

On the other hand, Hispanic mothers' nativity status was significantly protective in earlier models, and the cross-level interaction model shows considerable differences in the association of neighborhood level measures and birth weight outcomes for mothers of US vs non-US nativity. Hispanic-White isolation is significantly associated with an increase in the odds of low birth weight for US-born Hispanic women (OR = 1.091, 95% CI = 1.009,1.180), but does not have a significant association for foreign-born Hispanic women. Hispanic-Black isolation also continues to have a significant association with increased odds of low birth weight for US-born Hispanics, but there is no such effect for Hispanic mothers born outside the US. For US-born Hispanics, this model also suggests a negative (i.e., protective) association between Hispanic-Asian isolation and low birth weight outcomes (OR = 0.919, 95% CI = 0.857,0.985). Living in an immigrant neighborhood predicts a 3.7% increase in the odds of low birth weight for US-born Hispanic women for each standard deviation increase in the immigrant neighborhood scale (OR = 1.109, 95% CI = 1.044,1.178). For foreign-born Hispanic women, the associations between neighborhood level variables and low birth weight outcomes are not significant, but the trends suggest a protective association between immigrant neighborhoods and a decrease in the odds of low birth weight.

Multinomial Low Birth Weight Outcomes

Tables 2-13, 2-14, and 2-15 provide the results of multinomial models treating small for gestational age birth and appropriate for gestational age preterm birth as competing risks (normal birth weight is the referent). Table 2-13 shows that none of the neighborhood-level predictors have a significant association with appropriate for gestational age low birth weight births, but Black-White isolation has a significant association with increased odds of small for gestational age low birth weight birth; living in an isolated neighborhood predicts a 16% increase in the odds of small for gestational age low birth weight (OR = 1.165, 95% CI = 1.031,1.316). Living in an immigrant neighborhood also contributes to a 3.7% increased odds of small for gestational age low birth weight birth for each standard deviation increase in the score of the immigrant neighborhood scale (OR = 1.112, 95% CI = 1.015,1.219).

Results for multinomial logit models for Hispanic infants, shown in Table 2-14, indicate that mother's residence in an Hispanic-White isolated neighborhood is associated with increased odds of low birth weight, regardless of etiology. For appropriate for gestational age, early births, isolation from Whites predicts a 14% increase in the odds of low birth weight (OR = 1.147, 95% CI = 1.062,1.238). The odds of a small for gestational age birth associated with Hispanic-White isolation is 1.110 (95% CI = 1.047,1.176). Another similarity between neighborhood factors and association with the two types of low birth weight is the positive predictive relationship between living in an immigrant neighborhood and increased odds of both appropriate for gestational age low birth weight births (OR = 1.069, 95% CI = 1.005,1.137) and small for gestational age low birth weight births (OR = 1.054, 95% CI = 1.005,1.105). Neighborhood levels of women's disadvantage is uniquely associated with increased odds of appropriate for gestational age low birth weight births (OR = 1.088, 95% CI = 1.001,1.182). Hispanic-Asian isolation has a unique association with decreased odds of small for gestational age low birth weight births (OR = 0.947, 95% CI = 0.898,0.999).

The multinomial results for appropriate for gestational age vs. small for gestational age births for Asian/Pacific Islander mothers in Table 2-15 reveal that, in contrast to Black or Hispanic mothers, segregation measures are uniquely associated with increased appropriate for gestational age low birth weight. Asian-Hispanic isolation is associated with a nearly 30% decreased odds of appropriate for gestational age low birth weight (OR = 0.737, 95% CI = 0.567,0.960). Surprisingly, Asian-Black isolation is associated with increased odds of appropriate for gestational age low birth weight births (OR = 1.207, 95% CI = 1.025,1.421). For both appropriate for gestational age and small for gestational age low birth weight births, women's disadvantage is the only neighborhood-level scale that is associated with an increase in the odds of these outcomes. Neighborhoods with higher levels of disadvantage for women predict a 7.6% increase in the odds of appropriate for gestational age low birth weight for each standard deviation increase (OR = 1.228, 95% CI = 1.032,1.462); for small for gestational age low birth weight, the predicted increase in odds is 4.8% (OR = 1.139, 95% CI = 1.009,1.286).

Discussion

Taken together, these results illustrate that the relationships between local racial residential segregation and low birth weight outcomes among several racial and ethnic groups are complex. We have illustrated that among Black mothers in Los Angeles County, a detrimental relationship between Black-White isolation (as measured at the Census tract level) and the odds of low birth weight persists after controlling for individual-level and other neighborhood characteristics, including the proportion of residents living in poverty. Strikingly, measures of segregation that incorporate multiple racial and ethnic groups do not have an independent association with the odds of low birth weight, which suggests that an important element of segregation for Blacks is structural separation from Whites rather than simple group isolation. The higher diversity tracts in which

Blacks live are more frequently characterized by Hispanic-Black co-occupancy rather than true multi-race neighborhood composition; this finding squares with the lack of an effect on Hispanic-Black isolation for Blacks. Living in low diversity areas is not associated with an increase in low birth weight unless these areas are also Black-White isolated tracts. Neighborhoods with higher proportions of non-English speaking immigrants also have a negative association with Black women's pregnancy outcomes, a fairly consistent finding across models for Black women.

For African American mothers, the association between Black-White isolation and low birth weight appears to operate through the incidence of small for gestational age low birth weight. Living in a racially segregated neighborhood may expose African American women to the types of stressors and/or health behaviors that lead to intrauterine growth restriction. Because placental pathology is the most common reason for intrauterine growth restriction, these results suggest that living in a Black-White isolated neighborhood may have vascular consequences for Black women. It is certainly possible that longer-term exposure to the various conditions that might characterize racially-isolated neighborhoods, including political isolation, proximity to lower-quality neighborhoods and poorer access to social and material resources, could create a chronically stressful environment which could lead to vascular dysfunction and intrauterine growth restriction.

Furthermore, the descriptive results shown in Figure 2-3 illustrate that the highest rates of low birth weight are in black-isolated but non-poor tracts; it is possible that middle- and upper-class black women encounter high levels of social and psychological stress at the intersection of gender and class which could contribute to intrauterine growth restriction. For instance, educated black women with professional careers tend to work in environments with more white individuals than their less educated counterparts, which could contribute to greater incidence of stereotype threat (that is, being exposed to others whom they perceive as negatively judging their pregnancy). In a racially isolated neighborhood, however, they may also encounter negative pressure from family, neighbors, or friends for eschewing their black roots (e.g., "not black enough"). This "shifting" that Black women must accomplish as they move through the various spheres of their lives is documented through the African American Women's Voices Project by Jones and Shorter-Gooden

(2004); the constant renegotiation of social status and social identity induces significant stress which may contribute to intrauterine growth restriction among Black women.

For other racial and ethnic groups, the association between various inter-group isolation measures and birth weight is less clear. Hispanic-White isolation is consistently associated with increased odds of low birth weight birth for Hispanic mothers. An apparent detrimental effect of isolation from Blacks is mitigated by the inclusion of the immigrant neighborhood scale, but not by percentage of residents living in poverty, suggesting that any negative consequences of isolation from Blacks are not simply a product of higher concentration of poverty or structural disadvantages in Hispanic neighborhoods that are isolated from Blacks. One possible explanation (of many plausible ones) for the negative relationship between birth weight and Hispanics' isolation from Blacks might involve mobility – that is, Hispanics leaving neighborhoods that are isolated from Blacks (and that have higher proportions of immigrant residents) may be more likely to move into middle-class Black neighborhoods (Charles, 2009). If this is the case, the association between increased isolation from Blacks and increased low birth weight among Hispanic women may be related to the upward mobility of the Hispanics who have moved into neighborhoods that are less isolated from Blacks. Importantly, we do not find evidence for a similar effect for African Americans, whose birth outcomes are not associated in any way with separation from or proximity to Hispanics, bolstering an explanation of mobility (as opposed to, for example, a direct benefit of Hispanic-Black co-residence, which could be expected to improve outcomes for both groups).

The multinomial analysis suggests that the relationship between Hispanic-White isolation and low birth weight operates through both appropriate for gestational age and small for gestational age low birth weight. This suggests that living in a Hispanic-White isolated neighborhood may have both vascular and infectious/inflammatory consequences for Hispanic women. Foreign-born status reduces the odds of both preterm appropriate for gestational age delivery and small for gestational age delivery, so it appears this is not a result of heterogeneity that exists by including both foreign-born and US-born Hispanic women. Rather, it suggests that the association between Hispanic-White isolation and low birth weight could operate in a protective fashion for foreign-born women through either pathway. The overall picture of the multinomial analysis, however, suggests that economic disadvantage at the individual level is particularly strongly associated with appropriate for gestational age preterm delivery; furthermore, women's disadvantage (e.g., unemployment, public assistance) at the neighborhood level is associated with appropriate for gestational age preterm delivery while it is not associated with small for gestational age delivery. It may be that acute economic shocks or lack of access to material resources among Hispanic women could produce vulnerability to infections or inflammation that lead to early parturition. Increased neighborhood poverty predicts reduced appropriate for gestational age births; though these results seem at odds with women's disadvantage results, this may be one indication of heterogeneity conferred by foreign-born and US born women in the model. Neighborhoods where poverty is high, but women's unemployment and public assistance rates are average, may indicate areas of high proportions of foreign-born residents (who do not qualify for public assistance, or where women do not report typical employment); though poor overall, the social circumstances in these neighborhoods may offer protection against acute economic shocks that could otherwise lead to vulnerability in terms of pregnancy.

On the other hand, results from the multinomial analysis point to a reduced role for economic conditions in the small for gestational age pathway. Isolation from whites and Asians predicts higher and lower risk of small for gestational age birth, respectively. Higher proportions of immigrants and non-English speaking residents also predicts higher odds of small for gestational age birth. However, individual economic circumstances do not have as large an influence as for appropriate for gestational age birth, nor do the neighborhood economic indicators. This may suggest that the pathway of small for gestational age is more susceptible to longer-term exposure stressors that could accumulate in isolated neighborhoods as describe above for African American women.

Among Asian and Pacific Islander mothers, a consistent relationship emerged between Asian-Hispanic isolation and decreased odds of low birth weight. It appears that while the coefficient for Asian-Hispanic isolation remained fairly consistent across models in Table 2-4, the significance measures (which depend upon the standard error) were less so; this may be related to higher correlation with the Census neighborhood disadvantage measures (poverty, women's disadvantage), suggesting that the relationship at least partly depends upon the level of neighborhood disadvantage. When taken together, the association between residence in a high diversity area and increased odds of low birth weight, the protective association between Asian-Hispanic isolation and low birth weight, and the stability of these estimates when both measures are included in the same model, provides strong evidence of a positive isolation, or ethnic enclave, effect for Asian/Pacific Islander mothers. If Asian American mothers benefit from living in areas with high numbers of other Asian/Pacific Islander residents, it is reasonable that isolation from Hispanics would figure most prominently in the racial isolation models because Hispanics are the most likely racial group with which Asians would co-occupy Census tracts and/or interact in daily life.

Higher levels of interaction with non-Asians, and Hispanics in particular, could breed stress in a number of ways: as the much smaller population group, Asian/Pacific Islander mothers living in areas with more Hispanics may face language barriers and other challenges to effectively carrying out daily activities (Finch et al., 2007). Alternatively, high interracial tensions between Asians and Hispanics, as have been documented in Los Angeles (Charles, 2009), may encourage stressful interpersonal interactions with members of the opposite group. With fewer co-ethnics from whom to draw support, Asian/Pacific Islander mothers in tracts with significant numbers of Hispanics may have more negative outcomes; indeed, the outcomes for Hispanic mothers are not affected by isolation from or proximity to Asian/Pacific Islander neighborhoods, suggesting that, like the Hispanic-Black isolation findings, this association is not because of a mutually negative outcome related to co-occupancy.

The multinomial analysis suggests that the protective effect of Asian-Hispanic isolation operates through decreased odds of appropriate for gestational age early birth. Among several possible explanations, this may suggest that living in a more racially isolated neighborhood is associated with a decrease in Asian/Pacific Islander women's susceptibility to infections that could precipitate a spontaneous preterm birth, resulting in an appropriate for gestational age, low birth weight baby. Because susceptibility to infections and preterm delivery may have a stronger relationship with acute or short-term stressors (as compared to IUGR, which may require more chronic exposure to stress), it is possible that the social benefits of an ethnic enclave work best at buffering the effects of acute stress events. For example, an individual income or emotional shock such as a job loss or a death in the family might be offset by neighbors' help and generosity in riding out the rough time; under different circumstances, this same shock could promote a pregnant woman's vulnerability to infection/inflammation.

Women's disadvantage was also strongly predictive of increases in both appropriate for gestational age and small for gestational age low birth weight births. When the two etiologies of low birth weight are considered separately, there appears to be an important relationship between individualized opportunity for women and low birth weight. This could raise concerns about neighborhood deprivation as a predictor of low birth weight for Asian/Pacific Islander mothers. Alternatively, it is possible that because Asian/Pacific Islander women have higher levels of education and professional employment themselves, they may feel less stressed in neighborhoods where most women occupy the same sociodemographic niches, regardless of race.

Both Hispanic and Asian Americans in Los Angeles have begun to experience increasing segregation from Whites, due in part to the increasing rate of immigration and patterns of post-immigration settlement (Charles, 2009). Previous research has suggested that both Asians and Hispanics may have a transitional relationship with segregation – as individuals attain higher socioeconomic status, they move into better, less segregated neighborhoods, a process known as spatial assimilation (Alba, Logan, Stults, Marzan, & Zhang, 1999; Charles, 2009). If the spatial assimilation model holds for Asian/Pacific Islanders and Hispanics, we would expect that isolation from Whites would have no, or a small (potentially protective), association with birth outcomes because this relationship is transitional and not structural. We find, however, some evidence that spatial assimilation may not offer an escape from segregation for Hispanic residents of Los Angeles County: isolation from Whites is detrimental, and any association of income with birth weight outcomes is subsumed by racial segregation. There is a clear difference in the relative importance of different neighborhood characteristics for Asians vs. Hispanics in Los Angeles County; it appears that the association between segregation and low birth weight for Hispanics more closely mirrors that of Blacks than of Asians, a somewhat surprising finding.

It is possible that this is something of an historical artifact in the sense that Hispanic immigration has occurred on a larger scale for a longer period of time in Los Angeles – though they make up a larger share of the population, the proportion of foreign-born Hispanic mothers is 67%, compared to over 80% for Asian mothers. Given more time in the Los Angeles County region, Asian/Pacific Islander's experiences with racial residential segregation might begin to look more like that of African Americans and Hispanics. Whether true or not, our results suggest that, at least during the time of this study, Asian/Pacific Islanders have a uniquely non-detrimental relationship with isolation from Whites as far as birth outcomes are concerned. The basic demographic characteristics of Asian immigrants, who are, on average, better educated and less poor, in conjunction with their "favored minority" status among Whites with regard to racial preferences for neighbors (Bobo, 2000; Charles, 2003, 2009), may result in a different experience entirely for Asian American groups as compared to Hispanic groups. In contrast, we find a stable negative relationship between Hispanic-White isolation and birth outcomes; this may suggest that Hispanics are becoming involuntarily confined to certain spaces within LA County in a similar fashion to Blacks.

With regard to measuring segregation, results from the diversity analyses call into question the usefulness of such a measure for understanding the spatial dimensions of multi-ethnic residential segregation. Though we had hypothesized that higher diversity might offer protection against poor birth outcomes by virtue of its opposite definition with regard to isolation, it is clear that the measure is considerably murkier in practice. Used as the sole measure of segregation, diversity largely had no association with birth outcomes, with the exception of Asian Americans as noted above. When used in conjunction with the isolation measures, higher diversity was often associated with increased odds of low birth weight (though not always a significant relationship), refuting our hypothesis. Several plausible causes, ranging from the methodological to the social-psychological, could explain these findings. To the latter point, if significant inter-racial tensions exist, as other researchers in Los Angeles have found (Bobo, 2000; Charles, 2009), then the detrimental association of higher diversity with lower birth weight might be a result of increased stress due to highly tense inter-group interactions. This might especially be true if higher diversity scores are more consistently the result of co-occupancy of multiple racial and ethnic minority groups rather than co-occupancy with Whites, which, if the Black-White and Hispanic-White isolation measures are to be believed, should be associated with improved birth outcomes.

The plausibility of neighborhood co-occupancy of people of color in the absence of Whites also plays a role in the potential methodological explanation for the findings. Methodologically speaking, it is not possible to know from the H score what kind of diversity it captures unless one delves into the precise racial/ethnic population breakdown of each tract. Though H measures the racial composition in relationship to the composition of the entire study area, tracts with equal numbers of two racial groups will score higher than tracts with higher proportions of two groups and a small number of a third group. In other words, findings of increased odds of low birth weight for Blacks as a function of higher diversity could be a function of Hispanic/Black co-occupancy of Census tracts causing a high diversity score rather than diversity represented by Black, White, Asian, and Hispanic residents causing a high diversity score. For example, if African Americans living in high diversity tracts are largely living with Hispanics, and these tracts also qualify as Hispanic-White isolated, the disadvantage of spatial isolation from Whites still applies, even though the tract is ostensibly “diverse.”

The associations between economic status and low birth weight are surprisingly equivocal in these analyses. The proxy measure of neighborhood economic status we used (e.g., the proportion of a tract’s residents in poverty) is positively associated with odds of low birth weight, regardless of race/ethnicity, when considered alone. Other measures of neighborhood income (median household income for the neighborhood, poverty isolation) did not reach significance even when used as the sole level-2 predictor. The association between tract-level poverty and low birth weight becomes less robust as isolation measures and other Census tract variables are added, disappearing altogether in the fully adjusted models. This corroborates the early descriptive results (see Figure 2-3) suggesting that low birth weight rates were similar across poverty status within levels of racially isolated/ non-isolated tracts. Importantly, this finding is somewhat at odds with other literature on segregation and birth outcomes, which more consistently identifies an independent effect of neighborhood income or poverty (e.g., Debbink & Bader, 2011; Grady, 2006). However, none of the literature to date has focused on the Los Angeles County area, which has wider variability in income across segregated areas than most Midwest or Northeastern cities, which have traditionally been the focus of these studies. If we treat racial isolation (e.g., from whites) as the neighborhood exposure, the distributions of income within exposed and non-exposed neighborhoods have more overlap in Los Angeles County neighborhoods than in other previously tested areas, which should allow for better estimation of these effects than in other areas where the distribution of neighborhood poverty in segregated vs. non-segregated areas are nearly entirely separate.

This is not to suggest that segregation, neighborhood disadvantage measures, and socioeconomic status are not intertwined in Los Angeles County, but that correlations between measures of these circumstances should be reduced, alleviating some multi-collinearity problems. Indeed, sensitivity analyses showed that partial correlations between these variables do not suggest levels of correlation (taking the other variables into account) that would preclude the use of the variables in the models on the basis of high collinearity. At the very least, the results we report suggest that neighborhood economic status alone cannot explain the association between racial isolation (especially of Blacks and Hispanics from Whites) and low birth weight outcomes in Los Angeles County. Furthermore, though others have posited that relationships between racial segregation (especially Black-White isolation) and health merely proxy for the concentration of poverty, these analyses suggest that the proportion of residents in poverty cannot explain the higher odds of low birth weight associated with racial segregation. This is not to say that economic status of a neighborhood does not play a role, but rather that racial isolation from Whites (for Blacks and

Hispanics) has a separate and significant relationship with low birth weight outcomes, irrespective of the level of poverty in the neighborhood.

The inclusion of other Census scales capturing residential turnover, higher rates of disadvantage in opportunity for women, and higher proportions of non-English speaking foreign-born residents mitigated the association between segregation and birth outcomes to some degree, though the effect was mild. For Hispanics and Blacks, the immigrant neighborhood measure was almost universally detrimental for both Blacks and US-born Hispanics (and all Hispanics, when not subdivided by nativity). Some of the purported benefits of living in an immigrant neighborhood (e.g., increased social support) would likely not extend to African Americans living in those neighborhoods (though others, such as increased safety, would ostensibly affect people of any race). Living in an immigrant neighborhood, however, and not "fitting in" to the demographic, might prove particularly stressful; coupled with the often lower socioeconomic status of immigrant neighborhoods, this stress could bolster the detrimental association between immigrant neighborhoods and birth outcomes for Blacks.

Limitations. As with nearly all segregation and health outcomes research to date, this analysis utilizes cross-sectional data. While the speculated mechanisms linking segregation to low birth weight include accumulated stress, we have no method by which to assess how long a mother lived in the neighborhood she resided in at the time of delivery. For this reason, this work can only add to the increasing body of evidence regarding an association between segregation and poor health outcomes (especially for Black Americans) but cannot posit a definite causal link. Though costly, a prospective study of adolescent girls followed throughout their reproductive lives would provide the evidence needed to definitively assess the association and any causal impact of neighborhood of residence on birth outcomes. Without explicit knowledge regarding the actual duration and timing of a woman's exposure to segregation and other neighborhood factors and her subsequent pregnancy outcomes, this work and studies like it can only make assertions as to the association of one with the other.

In addition to the temporal challenges, measuring local neighborhood racial isolation captures the relative racial concentrations of neighboring geographic units, and therefore provides insight into how a neighborhood may look and feel to the residents of that neighborhood; it does not, however, permit us to unpack the black box of factors which might produce the association between racial segregation and birth outcomes. Racial isolation measured at the local level captures not only an objective measure of the relative separation of groups from one another on a smaller scale, but also the host of interdependent circumstances that are a part of racial segregation. If we believe that racial segregation can impact health, then there must be a way in which racial segregation can get under the skin to cause health outcomes, which is more likely to occur at the local level (e.g., the individuals' experiences of living in a racially isolated neighborhood). Racial isolation at the local level captures what residents see, as well as the interdependent increased likelihoods of toxic exposures, decreased policing, depressed housing values, decreased wealth accumulation, etc.

As a cross-sectional study with limited ability to assess independent level variables on the potential pathway(s) from segregation to birth outcomes, this research does not provide the opportunity to unpack the factors that characterize racial isolation and identify the specific elements (or combinations of elements) that have a causal relationship with low birth weight outcomes. However, we would argue that, in the spirit of Link and Phelan and of Williams, residential segregation is the fundamental circumstance which permits, sustains, and creates the confluence of health risks and resiliencies in segregated neighborhoods (1995; 2001). As Massey and Denton contend, without segregation, economic depression in the middle of the last century would not have had the dramatic impact on the African American community which has reverberated through generations (1990). Mapping the relationship between segregation and low birth weight offers insight into the spatial nature of risk and resilience, and a starting place for further investigations.

That said, a handful of studies have begun to try to more definitively estimate the causal relationship between neighborhood environments (broadly speaking) and health outcomes through modeling that falls into a broad category of expanded counterfactual models (i.e., Rubin Causal

Models). Subramanian et al. summarize the utility of using various approaches (including propensity score matching) to determine neighborhood effects by eliminating back-door effects (e.g., using statistical modeling to block or control for factors which precede and influence the neighborhood circumstances – the "back door" to neighborhood environment) (2007). Any remaining effect could be considered the estimated causal influence of neighborhood. In another example, Sharkey and Elwert utilize marginal structural models to estimate multigenerational neighborhood deprivation effects on children's cognitive outcomes (2010).

Specifically, studies could begin to establish causality by explicitly utilizing the expanded counterfactual framework. Furthermore, we could begin to unpack the black box of racial segregation using longitudinal studies of neighborhood change and birth outcomes to gain insight into the nature of the relationship between racial isolation and birth outcomes. A longitudinal approach, including residential histories for mothers, would provide the opportunity to establish temporality (one important element of the causal argument) as well as utilize change over time to establish the impact of segregation by investigating the variation in outcomes for neighborhoods that change compared to those that do not.

As mentioned, another limitation is that California Vital Statistics data do not capture individual level data on health behaviors, such as mother's substance use or alcohol or tobacco exposure, or on mother's pre-pregnancy weight or weight gain during pregnancy. When analyzed at the level of population averages, health behaviors cannot explain the gap between Black and White Americans' low birth weight outcomes. However, if these health behaviors and other individual-level variables related to low birth weight are spatially clustered, neighborhood effects – such as the association of segregation with low birth weight – may be overstated. We would argue, however, that to the extent that health behaviors are clustered in association with segregation, these health behaviors might constitute a mechanistic link between segregation and low birth weight. For example, research has found that both alcohol and tobacco advertising are more common in segregated neighborhoods; Bell et al. have also found that Black women living in segregated areas are also more likely to smoke than Black women living in less segregated areas (2007). If the constrained opportunities, stress, and structural circumstances of racially segregated areas support and maintain risky health behaviors, such as smoking, this is one mechanism through which segregation may affect low birth weight rates.

Finally, there is significant danger in lumping all Hispanics and Asian/Pacific Islander groups together, as each category contains several subgroups with differing experiences. Sample size has thus far precluded meaningful work on a large scale with subgroup analysis; however, it is a necessity for understanding the relationship between the experiences of women of color at the intersection of race and gender and birth outcomes for those women. As the population of Asian/Pacific Islander and non-Mexican Hispanic immigrants grows, these subanalyses should be undertaken.

Conclusions

Though this work is observational in nature, it makes two points relevant to public health policy and social epidemiology. First, residential segregation is an important part of the social and spatial landscape facing women of color – both Hispanics' and African Americans' residence in neighborhoods that are isolated from Whites is associated with increased odds of low birth weight. Though we cannot, from this limited study, identify the mechanisms through which this risk operates, it is clear that identifying the characteristics of neighborhoods where the burden of low birth weight is particularly high is useful to public health practitioners and policy makers.

This is a particularly salient point when one considers the spatial clustering of low birth weight events vs. low birth weight rates; if we believe that neighborhoods contribute to the risk for low birth weight outcomes, we need to concentrate our efforts on those areas where the rate of low birth weight is disproportionately high. That is, if neighborhoods are contributing to risk, they are doing so in ways that would result in a difference in the proportion of births affected by low birth weight (i.e., differential exposures to neighborhood type create differences in rates of low birth weight).

On the other hand, we may be tempted to devote political and health care resources to those areas with the highest absolute numbers of low birth weight (low birth weight events); unfortunately, if these higher numbers are a result of population density and a generally higher number of births (which will, statistically speaking, include higher numbers of LBW births), concentrating efforts on these areas may actually work against a goal of reducing disparities in low birth weight. In fact, devoting efforts to addressing neighborhood factors specifically in areas where numbers of low birth weight are high, but rates are normal, would likely have low impact, as the evidence of a spatial exposure effect is low.

Second, the color lines in Los Angeles are shifting, as they undoubtedly will in other US cities in the future. A challenge for social epidemiology and public health policy is to understand and recognize these shifts while also attempting to understand how they might be related to health outcomes such as low birth weight. Los Angeles' demography – that is, significant populations of multiple racial and ethnic groups – has permitted us to investigate how various measures of segregation might relate to different etiologies of low birth weight outcomes for different race and ethnic groups.

As mentioned above, the declining population share for African Americans may mask the greater burden they bear for low birth weight in ecological analyses unless we investigate the spatial distributions of rates. Considerable attention must be paid to the social-structural context for African American women if racial disparities in low birth weight are to be rectified. For African American women, racial isolation may capture a confluence of structural disadvantages (e.g., schooling or health facilities), environmental exposures (e.g., lead or particulates), and psychological stressors (e.g., stereotype threat); furthermore, the historical context of racial isolation for African Americans suggests that thus far, little opportunity for stable integration exists. For example, whites tend to avoid relocating to integrated neighborhoods (South, Crowder, & Chavez, 2005), which contributes to increasing numbers of residents who are people of color (whether African American or some other racial or ethnic group).

Our results suggest that for black women, the association between racial isolation from whites and low birth weight may stem from chronic stressors that do not depend entirely on income; the accumulation of different types of stress at the intersection of individual race and gender with neighborhood isolation (e.g., stereotype threat, strong bonding social ties that deplete health resources, low access to social and political capital/resources, proximity to violence/poverty) may provide the circumstances necessary for the development of placental pathology. On the other hand, especially for Hispanic and Asian/Pacific Islander women, we see a role for both racial isolation and individual and neighborhood economic circumstances in appropriate for gestational age births. It may be that economic stressors among these groups predispose them to infection vulnerability instead of placental dysfunction.

Importantly, although sociological and public health literature largely understand both racial disparities in birth outcomes and hypersegregation as Black-White issues, these analyses suggest that there may be a divergence in experience for US vs. foreign-born Hispanics, as well as a difference between Hispanics and Asian/Pacific Islanders with regard to isolation from other racial groups (especially Whites). Though absolute rates of low birth weight are lower among Hispanic women than Black women, the neighborhood factors associated with low birth weight for Hispanic women mirror those for Blacks; this may be particularly true for US-born Hispanic women (as compared to foreign-born Hispanics), though in our study, these results are not definitive. In Los Angeles County, at least, Hispanic women's exposure to the structural barriers erected by racial segregation may be similar to that of Black Americans. In contrast, results for Asian/Pacific Islanders suggest that these women benefit from living in neighborhoods that are isolated from other groups, Hispanics in particular; given the high proportion of foreign-born women among Asian/Pacific Islander mothers, this may be attributable to an immigrant neighborhood, or so-called ethnic enclave effect.

Given the persistent association between isolation from Whites and increased risk of low birth weight for Hispanics and Blacks, we conclude that for these two groups, segregation acts as a unique exposure to circumstances that increase low birth weight, independently of other types of neighborhood exposures. We should seek to reverse the trend of continuing racial segregation, and we should be vigilant for any downturn in population averages of low birth weight for Hispanic women living in segregated areas. Addressing the sequelae of residence in a segregated environment may begin to narrow the gap between women of color and their White counterparts in the United States.

Table 2.1. Individual and neighborhood characteristics of mothers giving birth in Los Angeles County, 2000-2004

	All Mothers		White Mothers	Black Mothers		Hispanic Mothers		Asian/Pacific Isl. Mothers	
Individual Characteristics									
Total Births	733,966		130,843 (17.83%)	54,098 (7.50%)		452,753 (62.87%)		74,242 (10.30%)	
Low birth weight rate	47.6		35.9	91.94		45.1		49.5	
AGA low birth weight births (as % of all births)	1.84%		1.47%	3.81%		1.74%		1.65%	
SGA low birth weight births (as % of all births)	2.76%		2.03%	5.09%		2.62%		3.15%	
Birth weight in grams (mean)	3353.45		3428.48	3201.55		3366.94		3253.72	
Length of gestation in weeks (mean)	39.38		39.54	39.1		39.37		39.32	
Male infant (%)	51.08		51.24	51.09		50.91		51.68	
Mother's age in years (mean)	27.89		30.88	26.95		26.65		30.9	
Mother foreign born (%)	56.46		21.76	7.6		67.76		87.8	
Education									
Less than HS (%)	35.78		6.29	17.71		50.96		7.97	
HS/Some college (%)	44.9		44.29	66.85		42.9		42.39	
4+ yrs college (%)	19.33		49.41	15.44		6.14		49.64	
Nulliparous (%)	38.05		45.83	37.64		34.02		47.98	
Parity (mean)	1.14		0.86	1.32		1.27		0.77	
Parity (median)	1		0	1		1		1	
Complications (%)	14.85		20.62	18.31		12.64		14.97	
Prenatal Care Coverage (%)									
Medicaid	50.77		15.16	48.53		65.76		25.2	
Private	46.19		82.03	48.49		31.89		67.36	
Self	1.96		1.71	1.19		1.47		5.9	
Other	0.5		0.62	0.61		0.4		1.12	
None/Unknown	0.58		0.47	1.19		0.54		0.41	
Kotelchuck Index (%)									
Inadequate	14.63		7.85	19.47		16.45		11.22	
Intermediate	18.91		15.53	17.13		20.36		17.76	
Adequate	44.12		49.19	38.13		42.56		49.24	
Adequate plus	22.34		27.43	25.27		20.63		21.78	
Selected Neighborhood Characteristics									
Number of tracts	2041			1806		2027		1924	
Racial Segregation									
Isolated from Whites	--		--	15%		32%		9%	
Isolated from Asians	--		--	2%		27%		--	
Isolated from Hispanics	--		--	18%		--		5%	
Isolated from Blacks	--		--	--		33%		32%	
High diversity	--		--	13%		12%		12%	
Low diversity	--		--	9%		13%		11%	
Poverty (average %)	17.98		--	17.94		17.96		17.31	
Residential Turnover (range, SD)	(-6.73, 1.31)	0.88	--	(-5.59, 1.28)	0.86	(-5.59, 1.31)	0.86	(-4.52, 1.31)	0.87
Women's Disadvantage (range, SD)	(-2.33, 3.15)	0.86	--	(-1.95, 3.15)	0.84	(-2.01, 3.15)	0.86	(-2.01, 2.58)	0.82
Immigrant Neighborhood (range, SD)	(-2.72, 3.23)	0.83	--	(-2.20, 3.23)	0.79	(-2.72, 3.23)	0.83	(-2.11, 3.23)	0.84

Table 2-2a. Distribution of Census tracts by racial isolation and poverty status

		Proportion in Poverty		Totals
		<30%	30%+	
Black-White Isolated	No	1547 (87.40%)	223 (12.60%)	1770
	Yes	124 (45.76%)	147 (54.24%)	271
Hispanic-White Isolated	No	1305 (93.15%)	96 (6.85%)	1401
	Yes	366 (57.19%)	63 (42.81%)	640
Asian-White Isolated	No	1552 (83.40%)	309 (16.60%)	1861
	Yes	119 (66.11%)	61 (33.89%)	180
Totals		1671 (81.87%)	370 (18.31%)	2041

Table 2-2b. Distribution of low birth weight by tract racial isolation and poverty status

		Proportion in Poverty		Total LBW Births (%)
		<30%	30%+	
Black-White Isolated	No	4.44% (*n=22,144*)	4.97% (*n=4,420*)	4.52% (*n=26,564)*
	Yes	6.03% (*n=2,965*)	5.72% (*n=4,527*)	5.84% (*n=7,492)*
Hispanic-White Isolated	No	4.36% (*n=16,845*)	5.18% (*n=1,874*)	4.43% (*n=18,719)*
	Yes	5.10% (*n=8,264*)	5.36% (*n=7,073*)	5.22% (*n=15,337)*
Asian-White Isolated	No	4.56% (*n=23,241*)	5.32% (*n=7,652)*	4.73% (*n=30,893)*
	Yes	4.86% (*n=1,868)*	5.31% (*n=1,295)*	5.03% (*n=3,163)*
Total LBW Births (%)		4.58% (*n=25,109)*	5.32% (*n=8,947)*	4.75% (*n=34,056)*

Table 2-3. Odds ratios of HGLM predicting low birth weight by racial isolation for African American mothers, Los Angeles County 2000-2004

	Model 1			Model 2			Model 3			Model 4			Model 5		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors															
Male Infant	0.760	***	[0.714,0.809]	0.760	***	[0.714,0.810]	0.760	***	[0.714,0.809]	0.760	***	[0.714,0.810]	0.760	***	[0.714,0.810]
Mother's Age[a]	1.029	***	[1.024,1.035]	1.030	***	[1.024,1.036]	1.030	***	[1.024,1.036]	1.030	***	[1.024,1.036]	1.030	***	[1.024,1.036]
Mother's Age(2)	1.000		[1.000,1.001]	1.000		[1.000,1.001]	1.000		[1.000,1.001]	1.000		[1.000,1.001]	1.000		[1.000,1.001]
Mother's Education[a]	0.903	***	[0.886,0.920]	0.906	***	[0.889,0.924]	0.908	***	[0.890,0.925]	0.908	***	[0.891,0.926]	0.909	***	[0.891,0.927]
Nulliparity	1.291	***	[1.198,1.391]	1.297	***	[1.203,1.398]	1.300	***	[1.206,1.402]	1.300	***	[1.206,1.402]	1.303	***	[1.209,1.406]
Pregnancy Complications[a]	1.463	***	[1.409,1.519]	1.471	***	[1.417,1.528]	1.465	***	[1.411,1.521]	1.472	***	[1.417,1.528]	1.475	***	[1.420,1.533]
Insurance Coverage															
Medicaid	1.300	***	[1.213,1.394]	1.292	***	[1.205,1.385]	1.285	***	[1.197,1.378]	1.285	***	[1.198,1.379]	1.284	***	[1.197,1.378]
Self Pay	1.674	***	[1.293,2.167]	1.681	***	[1.298,2.177]	1.667	***	[1.288,2.159]	1.677	***	[1.295,2.172]	1.682	***	[1.299,2.179]
Other Payer	0.487	*	[0.267,0.886]	0.492	*	[0.270,0.896]	0.485	*	[0.266,0.883]	0.490	*	[0.269,0.894]	0.492	*	[0.270,0.897]
No Coverage	3.208	***	[2.569,4.005]	3.189	***	[2.553,3.984]	3.175	***	[2.542,3.966]	3.176	***	[2.542,3.968]	3.172	***	[2.538,3.963]
Kotelchuck Prenatal Care Index															
Inadequate	1.768	***	[1.592,1.964]	1.752	***	[1.577,1.947]	1.758	***	[1.583,1.953]	1.749	***	[1.574,1.944]	1.749	***	[1.574,1.943]
Intermediate	0.938		[0.838,1.049]	0.934		[0.835,1.045]	0.937		[0.837,1.048]	0.934		[0.835,1.045]	0.934		[0.835,1.045]
Adequate Plus	2.959	***	[2.736,3.201]	2.945	***	[2.722,3.186]	2.953	***	[2.730,3.195]	2.944	***	[2.721,3.185]	2.940	***	[2.717,3.181]
Census Tract Level Factors															
Proportion in poverty[a]							1.092	**	[1.022,1.166]	1.045		[0.971,1.126]	0.970		[0.838,1.123]
Segregation Scores															
Black-White Isolation				1.158	***	[1.071,1.253]				1.132	**	[1.038,1.235]	1.128	*	[1.020,1.247]
Black-Hispanic Isolation				0.915		[0.792,1.058]				0.942		[0.809,1.097]	1.020		[0.865,1.203]
Census Scale Scores															
Residential Turnover[a,c]													1.023		[0.965,1.084]
Women's Disadvantage[a,c]													1.051		[0.946,1.168]
Immigrant Neighborhood[a,c]													1.081	*	[1.003,1.164]
Intercept	0.050	***	[0.046,0.055]	0.047	***	[0.043,0.052]	0.049	***	[0.044,0.053]	0.047	***	[0.043,0.052]	0.047	***	[0.043,0.052]
Tau	0.0674												0.057		
Proportion variance explained													0.157		

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 2-4. Odds ratios of HGLM predicting low birth weight by racial isolation for Hispanic mothers, Los Angeles County 2000-2004

	Model 1			Model 2			Model 3			Model 4			Model 5		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors															
Male Infant	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]
Mother's Age[a]	1.011	***	[1.008,1.014]	1.012	***	[1.009,1.015]	1.012	***	[1.009,1.015]	1.012	***	[1.009,1.015]	1.012	***	[1.010,1.015]
Mother's Age(2)	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]
Mother Foreign Born	0.875	***	[0.843,0.907]	0.87	***	[0.838,0.903]	0.864	***	[0.833,0.897]	0.867	***	[0.835,0.899]	0.865	***	[0.833,0.898]
Mother's Education[a]	0.982	***	[0.977,0.988]	0.985	***	[0.979,0.990]	0.985	***	[0.979,0.990]	0.985	***	[0.980,0.991]	0.986	***	[0.980,0.991]
Nulliparity	1.57	***	[1.516,1.626]	1.577	***	[1.523,1.634]	1.578	***	[1.524,1.635]	1.579	***	[1.525,1.636]	1.582	***	[1.527,1.639]
Pregnancy Complications[a]	1.983	***	[1.940,2.027]	1.995	***	[1.952,2.039]	1.985	***	[1.943,2.029]	1.995	***	[1.952,2.040]	1.999	***	[1.955,2.043]
Insurance Coverage															
Medicaid	1.306	***	[1.257,1.356]	1.29	***	[1.242,1.340]	1.284	***	[1.236,1.334]	1.284	***	[1.235,1.334]	1.282	***	[1.234,1.332]
Self Pay	1.79	***	[1.599,2.005]	1.792	***	[1.601,2.007]	1.781	***	[1.591,1.994]	1.789	***	[1.598,2.003]	1.79	***	[1.598,2.004]
Other Payer	1.076		[0.828,1.398]	1.059		[0.814,1.376]	1.063		[0.818,1.381]	1.055		[0.812,1.371]	1.054		[0.811,1.371]
No Coverage	4.031	***	[3.538,4.592]	4.006	***	[3.515,4.565]	3.991	***	[3.503,4.547]	3.993	***	[3.504,4.550]	3.989	***	[3.501,4.546]
Kotelchuck Prenatal Care Index															
Inadequate	1.582	***	[1.502,1.665]	1.569	***	[1.490,1.652]	1.574	***	[1.495,1.657]	1.568	***	[1.489,1.651]	1.568	***	[1.489,1.651]
Intermediate	0.914	***	[0.869,0.962]	0.909	***	[0.864,0.956]	0.913	***	[0.868,0.960]	0.909	***	[0.865,0.956]	0.909	***	[0.864,0.956]
Adequate Plus	3.231	***	[3.115,3.351]	3.23	***	[3.114,3.350]	3.223	***	[3.108,3.343]	3.228	***	[3.112,3.348]	3.225	***	[3.109,3.345]
Census Tract Level Factors															
Proportion in poverty[a]							1.094	***	[1.058,1.131]	1.036		[0.998,1.075]	0.978		[0.913,1.047]
Segregation Scores															
Hispanic-White Isolation				1.177	***	[1.128,1.229]				1.157	***	[1.104,1.212]	1.123	***	[1.069,1.181]
Hispanic-Asian Isolation				0.966		[0.927,1.006]				0.964		[0.925,1.004]	0.964		[0.921,1.009]
Hispanic-Black Isolation				1.063	***	[1.026,1.102]				1.068	***	[1.030,1.107]	1.032		[0.989,1.076]
Census Scale Scores															
Residential Turnover[a,c]													1.017		[0.987,1.048]
Women's Disadvantage[a,c]													1.045		[0.990,1.103]
Immigrant Neighborhood[a,c]													1.063	**	[1.022,1.106]
Intercept	0.021	***	[0.020,0.022]	0.019	***	[0.018,0.020]	0.021	***	[0.020,0.022]	0.019	***	[0.018,0.020]	0.02	***	[0.018,0.021]
Tau	0.0263												0.022		
Proportion variance explained													0.152		

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 2-5. Odds ratios of HGLM predicting low birth weight by racial isolation for Asian/Pacific Islander mothers, Los Angeles County 2000-2004

	Model 1			Model 2			Model 3			Model 4			Model 5		
	O.R.	p	95% CI	O.R.	p	95% CI	O.R.	p	95% CI	O.R.	p	95% CI	O.R.	p	95% CI
Individual Level Factors															
Male Infant	0.839	***	[0.783,0.899]	0.839	***	[0.783,0.899]	0.839	***	[0.783,0.900]	0.839	***	[0.783,0.900]	0.839	***	[0.783,0.900]
Mother's Age[a]	0.986	***	[0.978,0.994]	0.986	**	[0.978,0.994]	0.987	**	[0.979,0.995]	0.987	**	[0.979,0.995]	0.988	**	[0.980,0.996]
Mother's Age(2)	1.003	***	[1.002,1.004]	1.003	***	[1.002,1.004]	1.003	***	[1.002,1.004]	1.003	***	[1.002,1.004]	1.003	***	[1.002,1.003]
Mother Foreign Born	0.971		[0.874,1.078]	0.97		[0.873,1.078]	0.958		[0.862,1.065]	0.96		[0.863,1.068]	0.952		[0.856,1.060]
Mother's Education[a]	0.97	***	[0.956,0.984]	0.971	***	[0.957,0.986]	0.973	***	[0.959,0.988]	0.973	***	[0.959,0.988]	0.977	**	[0.963,0.992]
Nulliparity	1.458	***	[1.354,1.570]	1.456	***	[1.352,1.568]	1.459	***	[1.355,1.571]	1.457	***	[1.353,1.569]	1.471	***	[1.365,1.585]
Pregnancy Complications[a]	1.891	***	[1.800,1.986]	1.89	***	[1.799,1.985]	1.892	***	[1.801,1.987]	1.891	***	[1.800,1.986]	1.893	***	[1.801,1.988]
Insurance Coverage															
Medicaid	1.137	**	[1.042,1.239]	1.131	**	[1.037,1.234]	1.114	*	[1.020,1.217]	1.115	*	[1.021,1.218]	1.102	*	[1.009,1.204]
Self Pay	0.9		[0.762,1.064]	0.913		[0.772,1.080]	0.903		[0.764,1.068]	0.913		[0.772,1.080]	0.909		[0.768,1.076]
Other Payer	1.211		[0.890,1.647]	1.21		[0.889,1.647]	1.201		[0.883,1.634]	1.203		[0.884,1.638]	1.193		[0.876,1.624]
No Coverage	2.792	***	[1.958,3.980]	2.804	***	[1.966,4.000]	2.77	***	[1.943,3.950]	2.788	***	[1.954,3.976]	2.776	***	[1.946,3.961]
Kotelchuck Prenatal Care Index															
Inadequate	1.559	***	[1.372,1.770]	1.561	***	[1.374,1.773]	1.555	***	[1.369,1.766]	1.558	***	[1.371,1.770]	1.553	***	[1.367,1.765]
Intermediate	0.962		[0.857,1.080]	0.961		[0.856,1.079]	0.96		[0.855,1.078]	0.96		[0.855,1.077]	0.958		[0.853,1.076]
Adequate Plus	2.81	***	[2.592,3.046]	2.812	***	[2.593,3.049]	2.811	***	[2.593,3.048]	2.813	***	[2.594,3.050]	2.814	***	[2.594,3.051]
Census Tract Level Factors															
Proportion in poverty[a]							1.075	*	[1.012,1.141]	1.067		[1.000,1.139]	0.917		[0.804,1.046]
Segregation Scores															
Asian-White Isolation				1.012		[0.912,1.122]				0.976		[0.874,1.089]	0.93		[0.826,1.048]
Asian-Hispanic Isolation				0.833	*	[0.720,0.964]				0.856	*	[0.738,0.994]	0.848	*	[0.728,0.987]
Asian-Black Isolation				1.03		[0.946,1.122]				1.046		[0.959,1.140]	1.027		[0.932,1.133]
Census Scale Scores															
Residential Turnover[a,c]													1.005		[0.946,1.067]
Women's Disadvantage[a,c]													1.153	**	[1.041,1.277]
Immigrant Neighborhood[a,c]													1.062		[0.979,1.153]
Intercept	0.027	***	[0.023,0.030]	0.027	***	[0.023,0.031]	0.027	***	[0.024,0.031]	0.027	***	[0.024,0.031]	0.028	***	[0.024,0.032]
Tau	0.0529												0.048		
Proportion variance explained													0.09		

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 2-6.Odds ratios of HGLM predicting low birth weight by racial diversity for African American mothers, Los Angeles County 2000-2004

	Model 1			Model 2			Model 3			Model 4			Model 5		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors															
Male Infant	0.760	***	[0.714,0.809]	0.759	***	[0.713,0.809]	0.760	***	[0.714,0.809]	0.76	***	[0.713,0.809]	0.76	***	[0.714,0.809]
Mother's Age[a]	1.029	***	[1.024,1.035]	1.029	***	[1.024,1.035]	1.030	***	[1.024,1.036]	1.03	***	[1.024,1.036]	1.031	***	[1.025,1.037]
Mother's Age(2)	1.000		[1.000,1.001]	1		[1.000,1.001]	1.000		[1.000,1.001]	1		[1.000,1.001]	1		[1.000,1.001]
Mother's Education[a]	0.903	***	[0.886,0.920]	0.903	***	[0.885,0.920]	0.908	***	[0.890,0.925]	0.907	***	[0.890,0.925]	0.909	***	[0.891,0.927]
Nulliparity	1.291	***	[1.198,1.391]	1.291	***	[1.197,1.391]	1.300	***	[1.206,1.402]	1.301	***	[1.207,1.402]	1.312	***	[1.217,1.415]
Pregnancy Complications[a]	1.463	***	[1.409,1.519]	1.465	***	[1.411,1.521]	1.465	***	[1.411,1.521]	1.467	***	[1.413,1.524]	1.466	***	[1.412,1.522]
Insurance Coverage															
Medicaid	1.300	***	[1.213,1.394]	1.302	***	[1.214,1.396]	1.285	***	[1.197,1.378]	1.285	***	[1.198,1.378]	1.28	***	[1.193,1.373]
Self Pay	1.674	***	[1.293,2.167]	1.675	***	[1.294,2.168]	1.667	***	[1.288,2.159]	1.667	***	[1.287,2.158]	1.672	***	[1.290,2.165]
Other Payer	0.487	*	[0.267,0.886]	0.486	*	[0.267,0.885]	0.485	*	[0.266,0.883]	0.484	*	[0.266,0.882]	0.486	*	[0.267,0.887]
No Coverage	3.208	***	[2.569,4.005]	3.211	***	[2.571,4.009]	3.175	***	[2.542,3.966]	3.179	***	[2.545,3.971]	3.168	***	[2.536,3.959]
Kotelchuck Prenatal Care Index															
Inadequate	1.768	***	[1.592,1.964]	1.769	***	[1.593,1.965]	1.758	***	[1.583,1.953]	1.759	***	[1.583,1.954]	1.76	***	[1.584,1.955]
Intermediate	0.938		[0.838,1.049]	0.938		[0.839,1.050]	0.937		[0.837,1.048]	0.938		[0.838,1.049]	0.938		[0.838,1.049]
Adequate Plus	2.959	***	[2.736,3.201]	2.96	***	[2.737,3.202]	2.953	***	[2.730,3.195]	2.955	***	[2.731,3.196]	2.956	***	[2.732,3.198]
Census Tract Level Factors															
Proportion in poverty[a]							1.092	**	[1.022,1.166]	1.102	**	[1.030,1.179]	1.027		[0.890,1.185]
Segregation Scores															
High Diversity				1.061		[0.961,1.171]				1.076		[0.975,1.188]	1.101		[0.996,1.217]
Low Diversity				0.982		[0.833,1.157]				0.948		[0.804,1.118]	0.908		[0.770,1.072]
Census Scale Scores															
Residential Turnover[a,c]													1.062	*	[1.004,1.122]
Women's Disadvantage[a,c]													1.087		[0.980,1.206]
Immigrant Neighborhood[a,c]													1.044		[0.977,1.115]
Intercept	0.050	***	[0.046,0.055]	0.05	***	[0.045,0.054]	0.049	***	[0.044,0.053]	0.048	***	[0.044,0.053]	0.048	***	[0.043,0.053]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 2-7. Odds ratios of HGLM predicting low birth weight by racial diversity for Hispanic mothers, Los Angeles County 2000-2004

	Model 1			Model 2			Model 3			Model 4			Model 5		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors															
Male Infant	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]
Mother's Age[a]	1.011	***	[1.008,1.014]	1.011	***	[1.009,1.014]	1.012	***	[1.009,1.015]	1.012	***	[1.009,1.015]	1.013	***	[1.010,1.015]
Mother's Age(2)	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]
Mother Foreign Born	0.875	***	[0.843,0.907]	0.875	***	[0.843,0.907]	0.864	***	[0.833,0.897]	0.865	***	[0.834,0.898]	0.863	***	[0.832,0.896]
Mother's Education[a]	0.982	***	[0.977,0.988]	0.983	***	[0.977,0.988]	0.985	***	[0.979,0.990]	0.985	***	[0.979,0.990]	0.986	***	[0.980,0.991]
Nulliparity	1.57	***	[1.516,1.626]	1.571	***	[1.517,1.628]	1.578	***	[1.524,1.635]	1.578	***	[1.524,1.635]	1.584	***	[1.530,1.641]
Pregnancy Complications[a]	1.983	***	[1.940,2.027]	1.985	***	[1.942,2.028]	1.985	***	[1.943,2.029]	1.987	***	[1.944,2.031]	1.997	***	[1.954,2.041]
Insurance Coverage															
Medicaid	1.306	***	[1.257,1.356]	1.303	***	[1.254,1.353]	1.284	***	[1.236,1.334]	1.284	***	[1.235,1.334]	1.282	***	[1.233,1.332]
Self Pay	1.79	***	[1.599,2.005]	1.791	***	[1.600,2.005]	1.781	***	[1.591,1.994]	1.782	***	[1.591,1.995]	1.784	***	[1.594,1.998]
Other Payer	1.076		[0.828,1.398]	1.072		[0.825,1.393]	1.063		[0.818,1.381]	1.061		[0.817,1.379]	1.058		[0.814,1.375]
No Coverage	4.031	***	[3.538,4.592]	4.029	***	[3.536,4.590]	3.991	***	[3.503,4.547]	3.993	***	[3.505,4.550]	3.978	***	[3.491,4.533]
Kotelchuck Prenatal Care Index															
Inadequate	1.582	***	[1.502,1.665]	1.577	***	[1.498,1.660]	1.574	***	[1.495,1.657]	1.571	***	[1.492,1.654]	1.572	***	[1.493,1.655]
Intermediate	0.914	***	[0.869,0.962]	0.913	***	[0.868,0.960]	0.913	***	[0.868,0.960]	0.912	***	[0.867,0.959]	0.911	***	[0.866,0.958]
Adequate Plus	3.231	***	[3.115,3.351]	3.229	***	[3.113,3.349]	3.223	***	[3.108,3.343]	3.222	***	[3.107,3.342]	3.222	***	[3.107,3.342]
Census Tract Level Factors															
Proportion in poverty[a]							1.094	***	[1.058,1.131]	1.087	***	[1.051,1.125]	0.973		[0.909,1.041]
Segregation Scores															
High Diversity				1.006		[0.947,1.069]				1.015		[0.955,1.079]	1.047		[0.985,1.113]
Low Diversity				1.067	**	[1.021,1.115]				1.044		[0.998,1.092]	0.973		[0.927,1.021]
Census Scale Scores															
Residential Turnover[a,c]													1.039	**	[1.010,1.069]
Women's Disadvantage[a,c]													1.085	**	[1.031,1.142]
Immigrant Neighborhood[a,c]													1.115	***	[1.078,1.153]
Intercept	0.021	***	[0.020,0.022]	0.021	***	[0.020,0.022]	0.021	***	[0.020,0.022]	0.021	***	[0.020,0.022]	0.02	***	[0.019,0.021]
Tau															

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 2-8. Odds ratios of HGLM predicting low birth weight by racial diversity for Asian/Pacific Islander mothers, Los Angeles County 2000-2004

	Model 1			Model 2			Model 3			Model 4			Model 5		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors															
Male Infant	0.839	***	[0.783,0.899]	0.839	***	[0.783,0.900]	0.839	***	[0.783,0.900]	0.84	***	[0.783,0.900]	0.839	***	[0.783,0.900]
Mother's Age[a]	0.986	***	[0.978,0.994]	0.987	**	[0.979,0.995]	0.987	**	[0.979,0.995]	0.988	**	[0.979,0.996]	0.989	**	[0.980,0.997]
Mother's Age(2)	1.003	***	[1.002,1.004]	1.003	***	[1.002,1.003]	1.003	***	[1.002,1.004]	1.003	***	[1.002,1.003]	1.003	***	[1.002,1.003]
Mother Foreign Born	0.971		[0.874,1.078]	0.974		[0.877,1.083]	0.958		[0.862,1.065]	0.962		[0.865,1.070]	0.955		[0.858,1.063]
Mother's Education[a]	0.97	***	[0.956,0.984]	0.97	***	[0.956,0.985]	0.973	***	[0.959,0.988]	0.974	***	[0.959,0.988]	0.978	**	[0.963,0.993]
Nulliparity	1.458	***	[1.354,1.570]	1.462	***	[1.357,1.574]	1.459	***	[1.355,1.571]	1.462	***	[1.358,1.575]	1.476	***	[1.370,1.590]
Pregnancy Complications[a]	1.891	***	[1.800,1.986]	1.895	***	[1.804,1.991]	1.892	***	[1.801,1.987]	1.897	***	[1.806,1.992]	1.899	***	[1.807,1.995]
Insurance Coverage															
Medicaid	1.137	**	[1.042,1.239]	1.137	**	[1.042,1.240]	1.114	*	[1.020,1.217]	1.114	*	[1.020,1.217]	1.101	*	[1.007,1.203]
Self Pay	0.9		[0.762,1.064]	0.903		[0.764,1.067]	0.903		[0.764,1.068]	0.906		[0.766,1.071]	0.901		[0.762,1.066]
Other Payer	1.211		[0.890,1.647]	1.216		[0.894,1.655]	1.201		[0.883,1.634]	1.206		[0.886,1.641]	1.192		[0.875,1.623]
No Coverage	2.792	***	[1.958,3.980]	2.797	***	[1.961,3.990]	2.77	***	[1.943,3.950]	2.776	***	[1.946,3.960]	2.757	***	[1.933,3.934]
Kotelchuck Prenatal Care Index															
Inadequate	1.559	***	[1.372,1.770]	1.55	***	[1.364,1.762]	1.555	***	[1.369,1.766]	1.547	***	[1.361,1.758]	1.544	***	[1.358,1.754]
Intermediate	0.962		[0.857,1.080]	0.963		[0.857,1.081]	0.96		[0.855,1.078]	0.961		[0.856,1.079]	0.96		[0.855,1.078]
Adequate Plus	2.81	***	[2.592,3.046]	2.8	***	[2.582,3.036]	2.811	***	[2.593,3.048]	2.801	***	[2.583,3.037]	2.804	***	[2.586,3.041]
Census Tract Level Factors															
Proportion in poverty[a]							1.075	*	[1.012,1.141]	1.074	*	[1.011,1.140]	0.933		[0.821,1.062]
Segregation Scores															
High Diversity				1.108	*	[1.011,1.215]				1.107	*	[1.009,1.213]	1.107	*	[1.009,1.215]
Low Diversity				0.964		[0.742,1.251]				0.964		[0.743,1.251]	0.942		[0.725,1.224]
Census Scale Scores															
Residential Turnover[a,c]													1.007		[0.949,1.070]
Women's Disadvantage[a,c]													1.157	**	[1.047,1.279]
Immigrant Neighborhood[a,c]													1.037		[0.977,1.101]
Intercept	0.027	***	[0.023,0.030]	0.026	***	[0.023,0.030]	0.027	***	[0.024,0.031]	0.027	***	[0.023,0.031]	0.027	***	[0.024,0.031]
Tau															

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 2-9. Odds ratios of HGLM comparing racial isolation and racial diversity for predicting low birth weight for African American mothers, Los Angeles County 2000-2004

	Isolation Only			**Diversity Only**			**Diversity and Isolation**		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors									
Male Infant	0.760	***	[0.714,0.810]	0.76	***	[0.714,0.809]	0.76	***	[0.714,0.809]
Mother's Age[a]	1.030	***	[1.024,1.036]	1.031	***	[1.025,1.037]	1.03	***	[1.024,1.036]
Mother's Age(2)	1.000		[1.000,1.001]	1		[1.000,1.001]	1		[1.000,1.001]
Mother's Education[a]	0.909	***	[0.891,0.927]	0.909	***	[0.891,0.927]	0.909	***	[0.891,0.927]
Nulliparity	1.303	***	[1.209,1.406]	1.312	***	[1.217,1.415]	1.305	***	[1.210,1.408]
Pregnancy Complications[a]	1.475	***	[1.420,1.533]	1.466	***	[1.412,1.522]	1.482	***	[1.426,1.540]
Insurance Coverage									
Medicaid	1.284	***	[1.197,1.378]	1.28	***	[1.193,1.373]	1.285	***	[1.197,1.379]
Self Pay	1.682	***	[1.299,2.179]	1.672	***	[1.290,2.165]	1.685	***	[1.300,2.182]
Other Payer	0.492	*	[0.270,0.897]	0.486	*	[0.267,0.887]	0.493	*	[0.270,0.899]
No Coverage	3.172	***	[2.538,3.963]	3.168	***	[2.536,3.959]	3.179	***	[2.544,3.973]
Kotelchuck Prenatal Care Index									
Inadequate	1.749	***	[1.574,1.943]	1.76	***	[1.584,1.955]	1.747	***	[1.572,1.941]
Intermediate	0.934		[0.835,1.045]	0.938		[0.838,1.049]	0.935		[0.835,1.046]
Adequate Plus	2.940	***	[2.717,3.181]	2.956	***	[2.732,3.198]	2.939	***	[2.716,3.180]
Census Tract Level Factors									
Proportion in poverty[a]	0.970		[0.838,1.123]	1.027		[0.890,1.185]	0.973		[0.840,1.126]
Segregation Scores									
Black-White Isolation	1.128	*	[1.020,1.247]				1.173	**	[1.058,1.300]
Black-Hispanic Isolation	1.020		[0.865,1.203]				1.046		[0.887,1.233]
High Diversity				1.101		[0.996,1.217]	1.154	**	[1.040,1.281]
Low Diversity				0.908		[0.770,1.072]	0.887		[0.751,1.047]
Census Scale Scores									
Residential Turnover[a,c]	1.023		[0.965,1.084]	1.062	*	[1.004,1.122]	1.033		[0.975,1.096]
Women's Disadvantage[a,c]	1.051		[0.946,1.168]	1.087		[0.980,1.206]	1.059		[0.954,1.176]
Immigrant Neighborhood[a,c]	1.081	*	[1.003,1.164]	1.044		[0.977,1.115]	1.095	*	[1.015,1.180]
Intercept	0.047	***	[0.043,0.052]	0.048	***	[0.043,0.053]	0.045	***	[0.041,0.050]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 2-10. Odds ratios of HGLM comparing racial isolation and racial diversity for predicting low birth weight for Hispanic mothers, Los Angeles County 2000-2004

	Isolation Only			Diversity Only			Diversity and Isolation		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors									
Male Infant	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]
Mother's Age[a]	1.012	***	[1.010,1.015]	1.013	***	[1.010,1.015]	1.012	***	[1.010,1.015]
Mother's Age(2)	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]
Mother Foreign Born	0.865	***	[0.833,0.898]	0.863	***	[0.832,0.896]	0.864	***	[0.832,0.897]
Mother's Education[a]	0.986	***	[0.980,0.991]	0.986	***	[0.980,0.991]	0.986	***	[0.980,0.991]
Nulliparity	1.582	***	[1.527,1.639]	1.584	***	[1.530,1.641]	1.583	***	[1.528,1.640]
Pregnancy Complications[a]	1.999	***	[1.955,2.043]	1.997	***	[1.954,2.041]	2.003	***	[1.959,2.048]
Insurance Coverage									
Medicaid	1.282	***	[1.234,1.332]	1.282	***	[1.233,1.332]	1.282	***	[1.234,1.333]
Self Pay	1.79	***	[1.598,2.004]	1.784	***	[1.594,1.998]	1.788	***	[1.597,2.003]
Other Payer	1.054		[0.811,1.371]	1.058		[0.814,1.375]	1.055		[0.811,1.371]
No Coverage	3.989	***	[3.501,4.546]	3.978	***	[3.491,4.533]	3.98	***	[3.493,4.536]
Kotelchuck Prenatal Care Index									
Inadequate	1.568	***	[1.489,1.651]	1.572	***	[1.493,1.655]	1.568	***	[1.489,1.651]
Intermediate	0.909	***	[0.864,0.956]	0.911	***	[0.866,0.958]	0.909	***	[0.865,0.957]
Adequate Plus	3.225	***	[3.109,3.345]	3.222	***	[3.107,3.342]	3.224	***	[3.108,3.344]
Census Tract Level Factors									
Proportion in poverty[a]	0.978		[0.913,1.047]	0.973		[0.909,1.041]	0.968		[0.904,1.037]
Segregation Scores									
Hispanic-White Isolation	1.123	***	[1.069,1.181]				1.154	***	[1.097,1.214]
Hispanic-Asian Isolation	0.964		[0.921,1.009]				1.006		[0.957,1.058]
Hispanic-Black Isolation	1.032		[0.989,1.076]				1.06	**	[1.015,1.108]
High Diversity				1.047		[0.985,1.113]	1.117	***	[1.047,1.191]
Low Diversity				0.973		[0.927,1.021]	0.917	**	[0.867,0.969]
Census Scale Scores									
Residential Turnover[a,c]	1.017		[0.987,1.048]	1.039	**	[1.010,1.069]	1.017		[0.987,1.047]
Women's Disadvantage[a,c]	1.045		[0.990,1.103]	1.085	**	[1.031,1.142]	1.044		[0.990,1.102]
Immigrant Neighborhood[a,c]	1.063	**	[1.022,1.106]	1.115	***	[1.078,1.153]	1.072	***	[1.030,1.116]
Intercept	0.02	***	[0.018,0.021]	0.02	***	[0.019,0.021]	0.019	***	[0.018,0.020]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 2-11. Odds ratios of HGLM comparing racial isolation and racial diversity for predicting low birth weight for Asian/Pacific Islander mothers, Los Angeles County 2000-2004

	Isolation Only			Diversity Only			Diversity and Isolation		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors									
Male Infant	0.839	***	[0.783,0.900]	0.839	***	[0.783,0.900]	0.84	***	[0.783,0.900]
Mother's Age[a]	0.988	**	[0.980,0.996]	0.989	**	[0.980,0.997]	0.988	**	[0.980,0.997]
Mother's Age(2)	1.003	***	[1.002,1.003]	1.003	***	[1.002,1.003]	1.003	***	[1.002,1.003]
Mother Foreign Born	0.952		[0.856,1.060]	0.955		[0.858,1.063]	0.954		[0.857,1.062]
Mother's Education[a]	0.977	**	[0.963,0.992]	0.978	**	[0.963,0.993]	0.978	**	[0.963,0.993]
Nulliparity	1.471	***	[1.365,1.585]	1.476	***	[1.370,1.590]	1.473	***	[1.367,1.587]
Pregnancy Complications[a]	1.893	***	[1.801,1.988]	1.899	***	[1.807,1.995]	1.898	***	[1.807,1.995]
Insurance Coverage							1.102	*	[1.008,1.204]
Medicaid	1.102	*	[1.009,1.204]	1.101	*	[1.007,1.203]	0.909		[0.768,1.075]
Self Pay	0.909		[0.768,1.076]	0.901		[0.762,1.066]	1.194		[0.877,1.627]
Other Payer	1.193		[0.876,1.624]	1.192		[0.875,1.623]	2.777	***	[1.946,3.964]
No Coverage	2.776	***	[1.946,3.961]	2.757	***	[1.933,3.934]	1.547	***	[1.361,1.758]
Kotelchuck Prenatal Care Index							0.959		[0.854,1.077]
Inadequate	1.553	***	[1.367,1.765]	1.544	***	[1.358,1.754]	2.806	***	[2.587,3.044]
Intermediate	0.958		[0.853,1.076]	0.96		[0.855,1.078]	1.036		[0.926,1.159]
Adequate Plus	2.814	***	[2.594,3.051]	2.804	***	[2.586,3.041]	0.928		[0.748,1.152]
Census Tract Level Factors									
Proportion in poverty[a]	0.917		[0.804,1.046]	0.933		[0.821,1.062]	0.919		[0.806,1.049]
Segregation Scores									
Asian-White Isolation	0.93		[0.826,1.048]				0.937		[0.832,1.055]
Asian-Hispanic Isolation	0.848	*	[0.728,0.987]				0.857	*	[0.735,0.998]
Asian-Black Isolation	1.027		[0.932,1.133]				1.051		[0.951,1.161]
High Diversity				1.107	*	[1.009,1.215]	1.104	*	[1.004,1.214]
Low Diversity				0.942		[0.725,1.224]	0.923		[0.710,1.201]
Census Scale Scores									
Residential Turnover[a,c]	1.005		[0.946,1.067]	1.007		[0.949,1.070]	1.004		[0.945,1.066]
Women's Disadvantage[a,c]	1.153	**	[1.041,1.277]	1.157	**	[1.047,1.279]	1.156	**	[1.044,1.281]
Immigrant Neighborhood[a,c]	1.062		[0.979,1.153]	1.037		[0.977,1.101]	1.056		[0.973,1.146]
Intercept	0.028	***	[0.024,0.032]	0.027	***	[0.024,0.031]	0.027	***	[0.023,0.031]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 12. Odds ratios of HGLM predicting low birth weight for US- and Foreign-born Asian/Pacific Islander and Hispanic Mothers, LA County 2000-2004

	US-born Asian/Pacific Islander			Foreign-born Asian/Pacific Islander			US-born Hispanic			Foreign-born Hispanic		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors												
Male Infant	0.840	***	[0.784,0.901]	0.840	***	[0.784,0.901]	0.881	***	[0.855,0.908]	0.881	***	[0.855,0.908]
Mother's Age[a]	0.988	**	[0.980,0.997]	0.988	**	[0.980,0.997]	1.013	***	[1.010,1.015]	1.013	***	[1.010,1.015]
Mother's Age(2)	1.003	***	[1.002,1.003]	1.003	***	[1.002,1.003]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]
Mother Foreign Born	0.941		[0.815,1.086]	0.941		[0.815,1.086]	0.886	***	[0.836,0.939]	0.886	***	[0.836,0.939]
Mother's Education[a]	0.978	**	[0.963,0.992]	0.978	**	[0.963,0.992]	0.985	***	[0.980,0.991]	0.985	***	[0.980,0.991]
Nulliparity	1.468	***	[1.362,1.581]	1.468	***	[1.362,1.581]	1.584	***	[1.529,1.641]	1.584	***	[1.529,1.641]
Pregnancy Complications[a]	1.892	***	[1.801,1.988]	1.892	***	[1.801,1.988]	2.001	***	[1.958,2.046]	2.001	***	[1.958,2.046]
Insurance Coverage												
Medicaid	1.107	*	[1.013,1.209]	1.107	*	[1.013,1.209]	1.285	***	[1.236,1.335]	1.285	***	[1.236,1.335]
Self Pay	0.911		[0.770,1.079]	0.911		[0.770,1.079]	1.789	***	[1.598,2.004]	1.789	***	[1.598,2.004]
Other Payer	1.195		[0.878,1.628]	1.195		[0.878,1.628]	1.055		[0.811,1.371]	1.055		[0.811,1.371]
No Coverage	2.771	***	[1.942,3.956]	2.771	***	[1.942,3.956]	3.996	***	[3.507,4.554]	3.996	***	[3.507,4.554]
Kotelchuck Prenatal Care Index												
Inadequate	1.554	***	[1.368,1.766]	1.554	***	[1.368,1.766]	1.568	***	[1.489,1.651]	1.568	***	[1.489,1.651]
Intermediate	0.957		[0.853,1.075]	0.957		[0.853,1.075]	0.909	***	[0.865,0.956]	0.909	***	[0.865,0.956]
Adequate Plus	2.815	***	[2.596,3.053]	2.815	***	[2.596,3.053]	3.225	***	[3.109,3.345]	3.225	***	[3.109,3.345]
Census Tract Level Factors												
Proportion in poverty[a]	0.847		[0.620,1.155]	1.093		[0.781,1.531]	0.984		[0.888,1.090]	0.965		[0.851,1.094]
Segregation Scores												
Isolation from whites	1.180		[0.855,1.630]	0.770		[0.549,1.082]	1.091	*	[1.009,1.180]	1.049		[0.956,1.150]
Asian-Hispanic Isolation	0.775		[0.504,1.192]	1.109		[0.705,1.743]						
Hispanic-Asian Isolation							0.919	*	[0.857,0.985]	1.071		[0.986,1.164]
Isolation from blacks	0.879		[0.689,1.122]	1.200		[0.924,1.558]	1.079	*	[1.011,1.152]	0.936		[0.866,1.012]
Census Scale Scores												
Residential Turnover[a,c]	0.884		[0.755,1.037]	1.152		[0.973,1.364]	1.001		[0.953,1.050]	1.010		[0.954,1.069]
Women's Disadvantage[a,c]	1.004		[0.789,1.276]	1.176		[0.909,1.521]	1.069		[0.982,1.164]	0.970		[0.877,1.073]
Immigrant Neighborhood[a,c]	1.204		[0.976,1.486]	0.866		[0.692,1.084]	1.109	***	[1.044,1.178]	0.935		[0.868,1.007]
Intercept	0.028	***	[0.024,0.033]	0.028	***	[0.024,0.033]	0.019	***	[0.018,0.021]	0.019	***	[0.018,0.021]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 13. Odds ratios of HGLM predicting competing risks of appropriate for gestational age and small for gestational age low birth weight births compared to normal weight births for African American mothers, Los Angeles County 2000-2004

	Appropriate for Gestational Age Low Birthweight Birth			**Small for Gestational Age Low Birthweight Birth**		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors						
Mother's Age[a]	1.032	***	[1.024,1.041]	1.030	***	[1.023,1.038]
Mother's Education[a]	0.922	***	[0.895,0.950]	0.900	***	[0.877,0.923]
Nulliparity	1.196	**	[1.068,1.338]	1.419	***	[1.290,1.561]
Pregnancy Complications[a]	1.613	***	[1.533,1.697]	1.363	***	[1.293,1.437]
Insurance Coverage						
Medicaid	1.161	**	[1.041,1.294]	1.405	***	[1.280,1.543]
Self Pay	1.394		[0.901,2.156]	1.747	**	[1.243,2.456]
Other Payer	0.546		[0.223,1.339]	0.493		[0.218,1.113]
No Coverage	3.596	***	[2.492,5.188]	2.786	***	[1.986,3.908]
Kotelchuck Prenatal Care Index						
Inadequate	2.554	***	[2.119,3.080]	1.416	***	[1.237,1.621]
Intermediate	0.979		[0.788,1.217]	0.927		[0.812,1.058]
Adequate Plus	6.697	***	[5.841,7.678]	1.670	***	[1.507,1.850]
Census Tract Level Factors						
Proportion in poverty[a]	1.000		[0.813,1.230]	0.970		[0.809,1.164]
Segregation Scores						
Black-White Isolation	1.103		[0.960,1.269]	1.165	*	[1.031,1.316]
Black-Hispanic Isolation	1.002		[0.805,1.247]	1.051		[0.866,1.275]
Census Scale Scores						
Residential Turnover[a,c]	1.075		[0.992,1.166]	1.002		[0.934,1.075]
Women's Disadvantage[a,c]	1.111		[0.959,1.287]	1.012		[0.889,1.151]
Immigrant Neighborhood[a,c]	1.053		[0.947,1.171]	1.112	*	[1.015,1.219]
Intercept	0.011	***	[0.010,0.013]	0.029	***	[0.026,0.033]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 14. Odds ratios of HGLM predicting competing risks of appropriate for gestational age and small for gestational age low birth weight births compared to normal weight births for Hispanic mothers, Los Angeles County 2000-2004

	Appropriate for Gestational Age Low Birthweight Birth			Small for Gestational Age Low Birthweight Birth		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors						
Mother's Age[a]	1.015	***	[1.010,1.019]	1.011	***	[1.007,1.014]
Mother's Age[2]	1.002	***	[1.001,1.002]	1.002	***	[1.001,1.002]
Mother Foreign Born	0.830	***	[0.782,0.881]	0.898	***	[0.856,0.943]
Mother's Education[a]	0.988	**	[0.980,0.997]	0.983	***	[0.976,0.990]
Nulliparity	1.417	***	[1.338,1.500]	1.696	***	[1.621,1.775]
Pregnancy Complications[a]	2.280	***	[2.213,2.350]	1.785	***	[1.733,1.839]
Insurance Coverage						
Medicaid	1.254	***	[1.180,1.333]	1.298	***	[1.234,1.364]
Self Pay	1.989	***	[1.663,2.380]	1.620	***	[1.396,1.881]
Other Payer	0.995		[0.657,1.507]	1.134		[0.812,1.585]
No Coverage	5.025	***	[4.047,6.240]	2.730	***	[2.219,3.358]
Kotelchuck Prenatal Care Index						
Inadequate	2.572	***	[2.342,2.824]	1.214	***	[1.137,1.296]
Intermediate	0.868	**	[0.781,0.966]	0.926	**	[0.875,0.981]
Adequate Plus	7.942	***	[7.439,8.480]	1.816	***	[1.732,1.905]
Census Tract Level Factors						
Proportion in poverty[a]	0.895	*	[0.806,0.993]	1.033		[0.952,1.122]
Segregation Scores						
Hispanic-White Isolation	1.147	**	[1.062,1.238]	1.110	**	[1.047,1.176]
Hispanic-Asian Isolation	1.002		[0.934,1.075]	0.947	*	[0.898,0.999]
Hispanic-Black Isolation	1.061		[0.995,1.132]	1.013		[0.964,1.064]
Census Scale Scores						
Residential Turnover[a,c]	1.014		[0.969,1.062]	1.021		[0.986,1.057]
Women's Disadvantage[a,c]	1.088	*	[1.001,1.182]	1.024		[0.960,1.092]
Immigrant Neighborhood[a,c]	1.069	*	[1.005,1.137]	1.054	*	[1.005,1.105]
Intercept	0.004	***	[0.004,0.005]	0.014	***	[0.013,0.014]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Table 15. Odds ratios of HGLM predicting competing risks of appropriate for gestational age and small for gestational age low birth weight births compared to normal weight births for Asian/Pacific Islander mothers, Los Angeles County 2000-2004

	Appropriate for Gestational Age Low Birthweight Birth			**Small for Gestational Age Low Birthweight Birth**		
	O.R.	**p**	**95% CI**	**O.R.**	**p**	**95% CI**
Individual Level Factors						
Mother's Age[a]	0.991		[0.976,1.005]	0.986	**	[0.976,0.996]
Mother's Age[2]	1.003	***	[1.002,1.004]	1.003	***	[1.002,1.004]
Mother Foreign Born	0.947		[0.787,1.139]	0.948		[0.830,1.083]
Mother's Education[a]	0.980		[0.954,1.006]	0.978	*	[0.960,0.997]
Nulliparity	1.315	***	[1.156,1.497]	1.552	***	[1.414,1.703]
Pregnancy Complications[a]	2.174	***	[2.026,2.333]	1.689	***	[1.583,1.802]
Insurance Coverage						
Medicaid	1.076		[0.920,1.259]	1.110		[0.995,1.238]
Self Pay	0.730		[0.524,1.018]	0.971		[0.796,1.184]
Other Payer	1.661	*	[1.042,2.648]	0.963		[0.632,1.467]
No Coverage	2.707	**	[1.298,5.645]	1.242		[0.629,2.455]
Kotelchuck Prenatal Care Index						
Inadequate	2.644	***	[2.063,3.391	1.170		[0.996,1.376]
Intermediate	0.902		[0.690,1.181	0.968		[0.850,1.103]
Adequate Plus	7.343	***	[6.294,8.567	1.708	***	[1.542,1.894]
Census Tract Level Factors						
Proportion in poverty[a]	0.951		[0.760,1.191]	0.876		[0.750,1.024]
Segregation Scores						
Asian-White Isolation	0.928		[0.762,1.130]	0.928		[0.806,1.067]
Asian-Hispanic Isolation	0.737	*	[0.567,0.960]	0.906		[0.761,1.078]
Asian-Black Isolation	1.207	*	[1.025,1.421]	0.936		[0.833,1.052]
Census Scale Scores						
Residential Turnover[a,c]	1.010		[0.912,1.119]	0.994		[0.926,1.068]
Women's Disadvantage[a,c]	1.228	*	[1.032,1.462]	1.139	*	[1.009,1.286]
Immigrant Neighborhood[a,c]	1.059		[0.923,1.216]	1.069		[0.971,1.178]
Intercept	0.005	***	[0.004,0.006]	0.021	***	[0.018,0.025]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
a - mean centered
b - logged values
c - mean scale of logged values

Figure 2-1. Proportion of Mothers from Four Racial and Ethnic Groups, Los Angeles County, 2000-2004

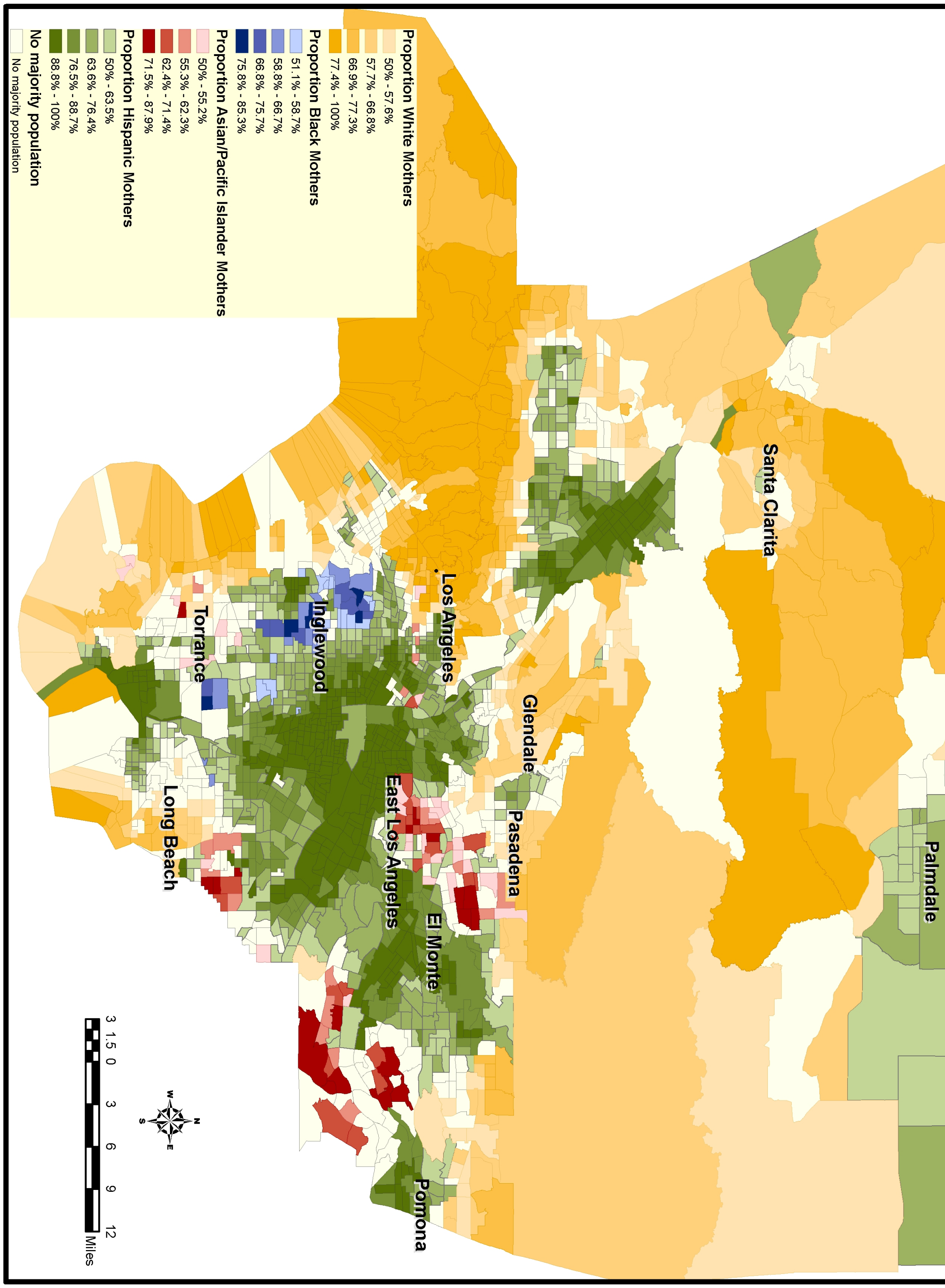


Figure 2-2 Panel A. Spatial Clustering of Low Birth Weight Events, Los Angeles County 2000-2004.

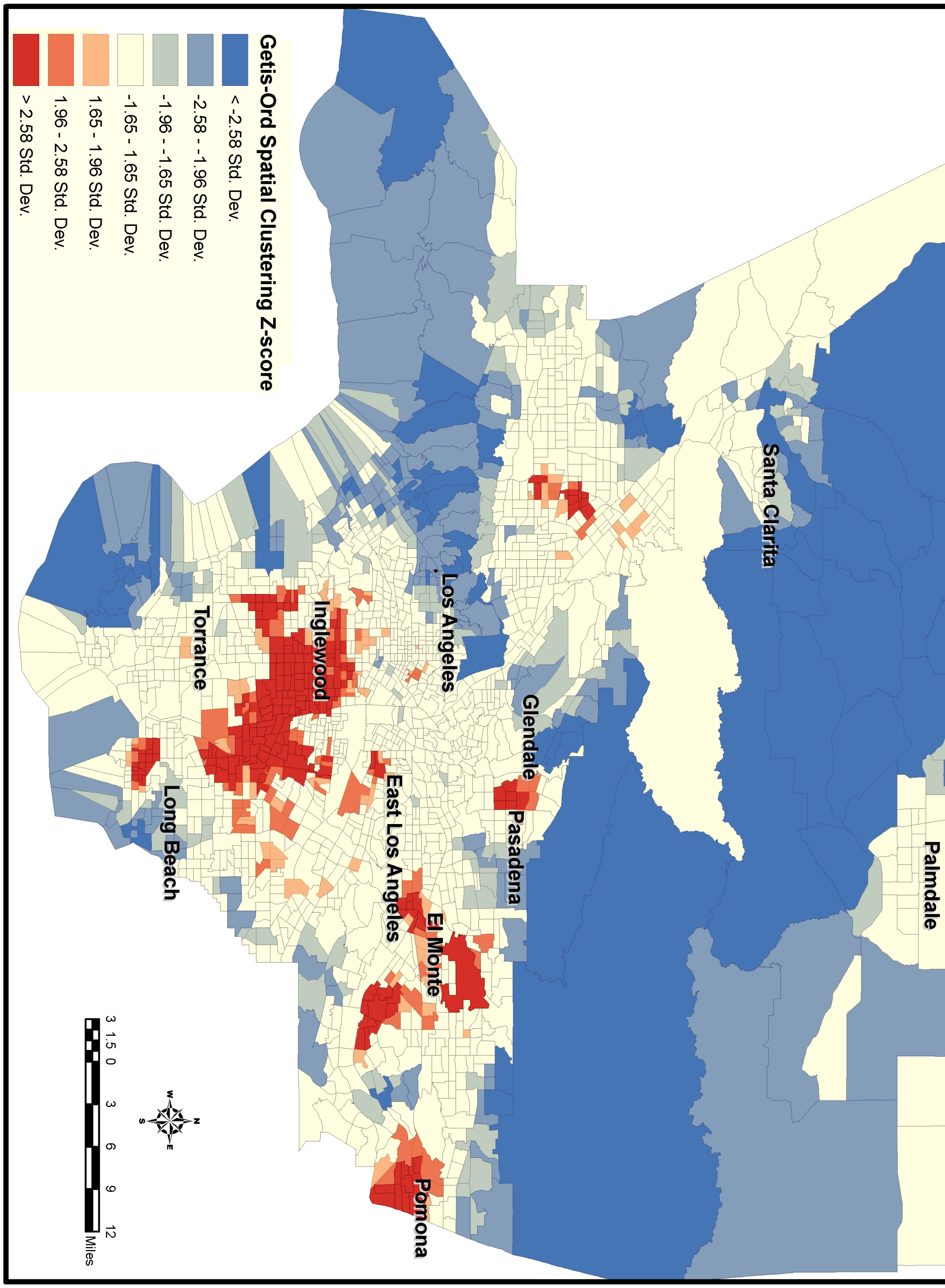


Figure 2-2 Panel B. Spatial Clustering of Low Birth Weight Rates, Los Angeles County 2000-2004.

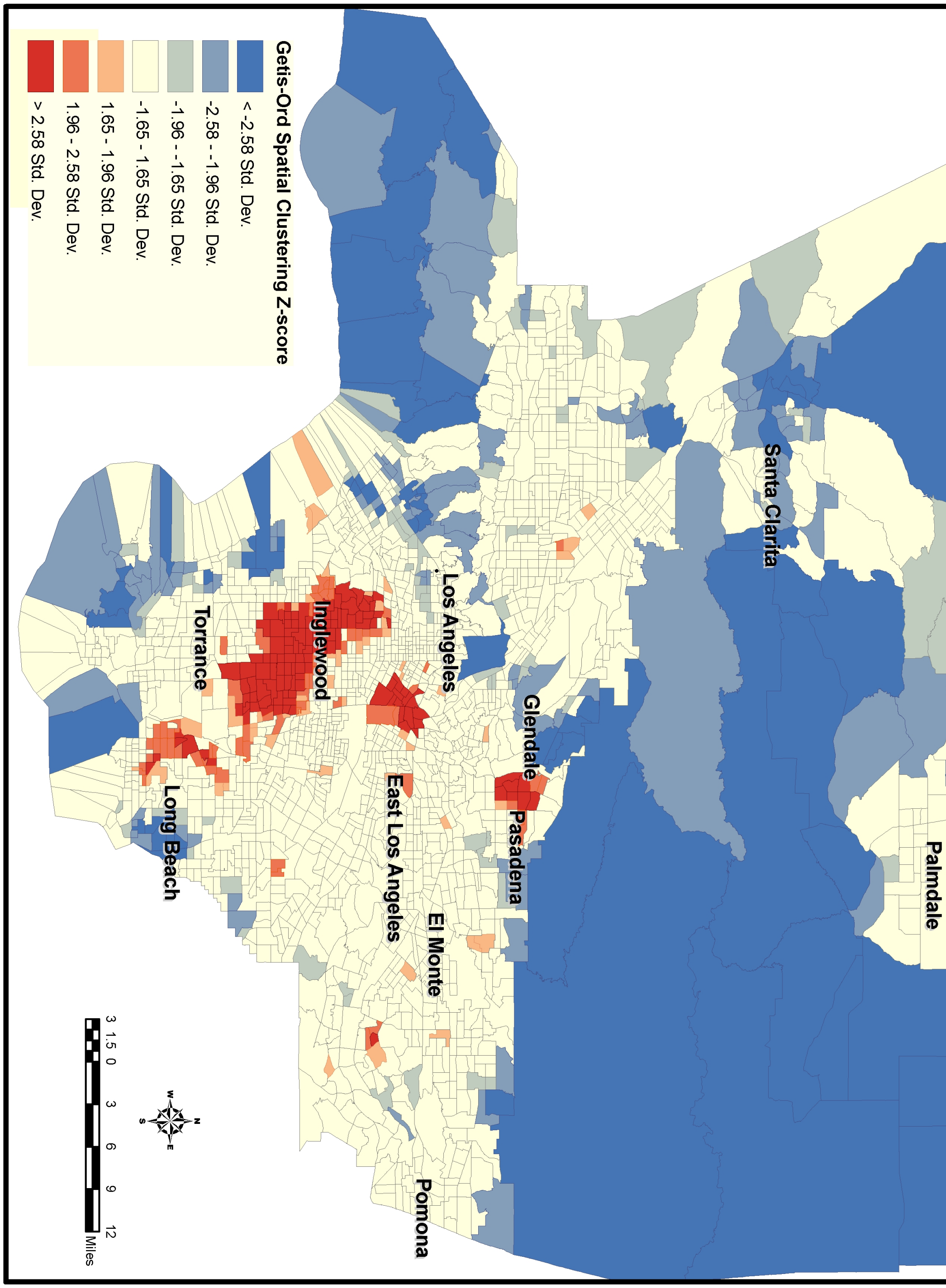
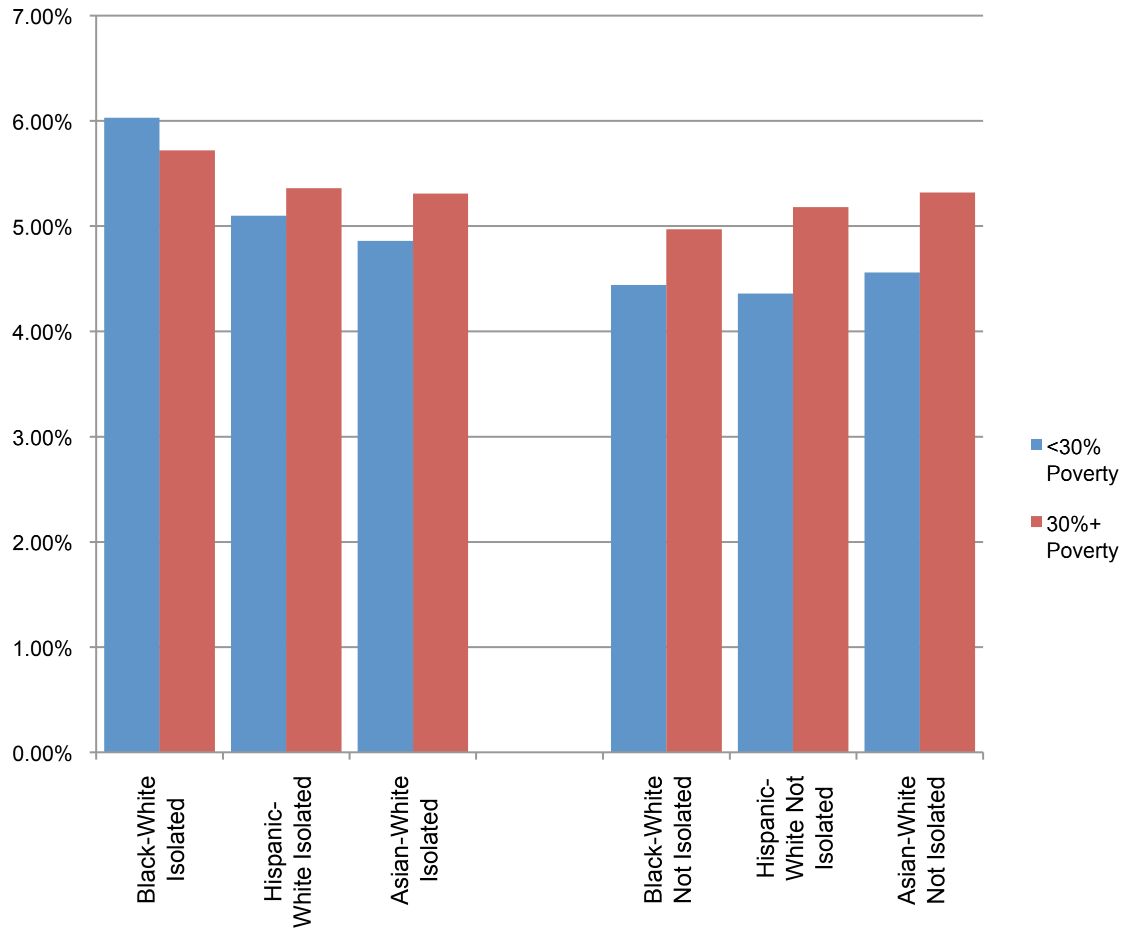


Figure 2-3. Rates of Low Birth Weight by Neighborhood Racial Isolation and Poverty, Los Angeles County, 2000-2004



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CHAPTER 3:

Do you know your neighbor?

Social Capital, Nativity, and Low Birth Weight in Los Angeles County, 2000-2004

Introduction

As previous research has demonstrated, low birth weight is associated with structural factors exogenous to mothers and their pregnancies (Auger et al., 2008; Behrman, Butler, & Institute of Medicine (U.S.)., 2007; J. W. Collins, David, Rankin, & Desireddi, 2009; Cubbin et al., 2008; Debbink & Bader, 2011; Grady & Wirth, 2011; Masi, Hawkley, Piotrowski, & Pickett, 2007; Morenoff, 2003). The inequality of life chances and choices manifested in racial disparities in low birth weight, prematurity, and infant mortality stems, at least in part, from contextual and structural inequalities (J. W. Collins & David, 2009; Jackson & Williams, 2006; Messer, Kaufman, Mendola, & Laraia, 2008; Williams, 2002; Williams & C. A. Collins, 2001). Neighborhood of residence during pregnancy, as a key driver of exposure to contextual or structural inequalities, has generated considerable interest in the social epidemiological literature. As a primary location where women spend much of their time, the residential neighborhood can offer insight into the types of living conditions, stressors, and resources available to women before and during their pregnancies. The places women live may put them at risk of risks for poor pregnancy outcomes, or, alternatively, provide greater exposure to factors that bolster health resiliency (Link & Phelan, 1995).

Furthermore, as Osypuk & Acevedo-Garcia point out, identifying the reasons for persistent disparities between Black and White women with regard to low birth weight, prematurity, and infant mortality requires identifying exposures that either "differentially influence Black and White [mothers], or uniquely impact Black or White [mothers]" (emphasis added) (2008, p. 1295).

Sociologists have demonstrated that the neighborhoods in which Blacks live are more likely to be segregated from Whites, and that at each level of individual income, Blacks live in more disadvantaged neighborhoods than Whites with similar income (Charles, 2009; Pattillo, 1999). Some estimates suggest that up to 40% of Black mothers may reside in hypersegregated cities during their pregnancies (Osypuk & Acevedo-Garcia, 2008). In other words, Blacks' neighborhoods of residence may represent both a unique type of risk exposure, and pathway for differentiating how certain circumstances impact pregnancy for Whites and Blacks. For instance, Blacks in segregated neighborhoods are uniquely exposed to the structural racism that perpetuates segregation, which may create, among other effects, a unique exposure to psychosocial stress related to the experience of racism (Rosenthal & Lobel, 2011; Dominguez, 2011; Ginsburg & Rapp, 1995; Geronimus, 1996; C. A. Collins & Williams, 1999). Living in a disadvantaged (not necessarily segregated) neighborhood may also maintain and reinforce risky health behaviors. For instance, residents of poor and/or segregated neighborhoods may have increased exposure to tobacco advertising and social networks of smokers, which may reduce immune function – the interplay of structural and individual factors may contribute to a differential impact of smoking on pregnancy for Black and White women based on the neighborhood in which they live.

The proposed links between neighborhoods – whether segregated or not – and birth outcomes fall largely into three non-exclusive groups: exogenously-created stress (or lack thereof), exposure to physiological toxins (or protection from them), and health behaviors (beneficial or detrimental). For instance, residents of poorer neighborhoods are disproportionately more likely to be exposed to crime and violence; the stress created by fear of crime may contribute to poor pregnancy outcomes via neuroendocrine pathways (Auger et al., 2008; Morenoff, 2003; Morenoff, Sampson, & Raudenbush, 2001). Women of color are also more likely to live in neighborhoods with high levels of environmental contaminants, which may directly impact a developing fetus, or may contribute to the onset of chronic diseases such as asthma or hypertension (Morello-Frosch & Lopez, 2006; Morello-Frosch, Jesdale, Sadd, & Pastor, 2010). Residents of segregated neighborhoods are less likely to have access to healthy food stores, making nutritious food choices difficult, and potentially contributing to obesity (Janevic, Borrell, Savitz, Herring, & Rundle, 2010; Morland, Wing, Diez Roux, & Poole, 2002; Laraia, Siega-Riz, Kaufman, & S. J. Jones, 2004; Brown, Vargas, Ang, & Pebley, 2008). And although improved access to prenatal care has not improved birth disparities, segregated and disadvantaged neighborhoods often suffer from lack of access to health care, especially of comparable quality to that in more advantaged neighborhoods (Grady & Ramírez, 2008; Institute of Medicine, 2003).

It is worth noting that not all proposed associations between neighborhoods and birth outcomes are negative; some studies have linked residence in a so-called ethnic enclaves as a contributor to the "healthy immigrant" paradox, whereby recently-immigrated Mexican women's birth outcomes are better than either their US born counterparts' or White women's, despite their generally lower socioeconomic status (Finch, Lim, Perez, & Do, 2007; Landale, Oropesa, & Gorman, 2000). These immigrant neighborhoods are also postulated to impact birth outcomes through similar stress and health behavior mechanisms. For example, high-immigrant neighborhoods may provide better social support and reduce stress for pregnant mothers, buffering against the potential effects of limited socioeconomic resources. So-called ethnic enclaves may protect foreign-born mothers from the negative structural and cultural influences associated with assimilation to the social constraints and opportunities that face US-born women in a similar socioeconomic position (Finch et al., 2007).

Unfortunately, though conceptual models are rich with plausible mechanisms linking neighborhood context and birth outcomes (Culhane & Elo, 2005; Massey, 2004), the available data often do not mirror this richness. Administrative and Census data, two of the main sources of information on neighborhood context, generally do not permit researchers to shed light on the black box which connects the disadvantaged neighborhood context to poor individual birth outcomes (Diez Roux, 2007; Elo, Mykyta, Margolis, & Culhane, 2009). Aside from health behaviors and health care access, the various mechanisms which link exogenous neighborhood circumstances and birth outcomes frequently invoke accumulation of (or protection from) stress and its biological fall out. In light of this, it is imperative to begin to understand how individuals perceive their neighborhoods and the availability of social and material resources, because these perceptions, coupled with objective experience, are the most likely biopsychological route between the neighborhood and birth outcomes.

In particular, social capital and the various ways in which it is created via social interaction have received significant attention as a potential mechanism linking neighborhoods and health (see review by (Kim, Subramanian, & Kawachi, 2008). The study of social capital as a factor of health risk or resiliency is not without controversy, due in some part to lack of consensus regarding definitions and imprecise theoretical explanation of the connection between social capital and health outcomes. For purposes of this paper, we employ a neighborhood or collective definition of social capital which posits that social capital is an attribute of communities, groups, or other collectives, rather than an attribute of individuals as described by the number, type, and strength of an individuals' social connections and the consequences and benefits thereof (Kawachi, Subramanian, & Kim, 2008). In reality, social capital emerges from interactions of individuals within a socially-connected network, and benefits and consequences accrue both to those who participate in the interactions and those who do not; in other words, social capital can be an attribute of both individuals and collectives.

However, with regard to the mechanistic relationship between neighborhoods and birth outcomes, we believe a collective definition best captures the intended meaning. For example, the social capital of individuals may well play a role in their health outcomes: a well connected individual may have many individuals to provide social support in a health crisis, which could include emotional, financial, or physical help. However, these benefits might accrue to any individual inclined to reach out and make social connections, regardless of the neighborhood in which he or she lives. By contrast, it is the overall level of connectedness created or social order imposed through social interaction that could alter how a neighborhood affects population-level birth outcomes, regardless of whether an individual mother participates in a given social interaction (Kawachi et al., 2008). For instance, in a neighborhood where people are, on average, very likely to know the neighborhood children and likely to intervene if children were causing trouble, residents would benefit from a stronger imposition of social order, and potential reductions in crime, violence, and concomitant stress, regardless of whether they themselves might intervene in a given situation. In another example, all residents could potentially benefit from the overall level of political participation of a neighborhood, which may help to bring local and/or regional resources to the area.

Portes has pointed out that high levels of social interaction and the creation of social capital may not always increase health resiliency (1998). For instance, increased social obligations may increase stress and decrease health outcomes. In particular, Portes and others make distinctions between bridging and bonding capital; bridging capital links individuals and groups of dissimilar characteristics, while bonding capital joins individuals and groups of similar backgrounds (1998; Hyyppä, 2010; Kawachi et al., 2008; Carpiano, 2008). Borrowing from network theory, bridging capital, as a means of expanding one's usual social network and typical available resources, may increase health resilience. On the other hand, bonding capital, as a means of fostering reciprocation and closeness among similar individuals, may actually increase network stress and decrease health outcomes (Kawachi et al., 2008).

Admittedly, the measurement of neighborhood social capital largely stems from the aggregation of individual reports or perceptions, but at present it serves as the only way to most closely measure the actual social interactions that create social capital (Harpham, 2008). Though objective measures to capture social capital have been proposed (e.g., crime data), these measures usually assess the outcomes of social interaction and the effects of expenditure of social capital rather than the social interactions themselves (which create or deplete social currency) (Kawachi et al., 2008; Kim et al., 2008).

Recently, the use of detailed survey data collected on individuals' perceptions of and experience with social interaction/connectedness in their neighborhoods has gained prominence (Mujahid, Diez Roux, Morenoff, & Raghunathan, 2007; Elo et al., 2009). For this study, we capitalized upon the availability of detailed and unique data from the Los Angeles Family and Neighborhood Survey (LAFANS) – a sample of nearly 3,000 households in Los Angeles County spread across 65 neighborhood clusters (Census tracts) – to contribute nuance to our understanding of the relationship between neighborhood social context and birth weight. The LAFANS contains numerous questions that capture various types social interaction that contribute to social capital. The use of individuals' perceptions of their neighborhood circumstances is likely to be at least somewhat reflective of reality; however, neighborhood measures constructed from these data have two potential limitations. The first is source bias, wherein using respondents' own evaluations of the quality of their neighborhoods to predict those same respondents' health outcomes presents a source bias problem (Diez Roux, 2007). For example, does disability lead to a more negative assessment of neighborhood walkability, or vice versa?

However, in this study we mitigate source bias by utilizing low birth weight outcomes (as reported in vital records data) for all births in the LAFANS neighborhoods during the same time frame as the survey data collection. That is, the birth outcomes in question are independent of the survey collection from a given neighborhood. In essence, this approach separates the aggregated neighborhood measures of residents' perceptions from the health outcomes in question, effectively nullifying source bias. However, this method assumes that an aggregated neighborhood measure of residents' perceptions will accurately capture some objective reality in that neighborhood, which can then be used to predict outcomes for another group of individuals who did not respond to the survey; this measurement error problem constitutes the second limitation of aggregating survey data. In response, Elo et al. recently undertook to demonstrate the correlations between low income pregnant women's perceptions of neighborhood violence or safety and actual neighborhood crime rates, and showed that women's perceptions are closely related to real crime rates (2009). Furthermore, we utilize an ecometric approach which helps to mitigate measurement error (Mujahid et al., 2007).

Taken together, analyses using these data sources may begin to reduce some of the gaps in understanding as to the specific aspects of neighborhood social capital that might be related to low birth weight. Placing each birth in the tract of residence for the mother offers the opportunity to identify which elements of perceived neighborhood social and material capital (as reported by

LAFANS respondents) might be related to women's pregnancy outcomes. We explore how neighborhood measures of social capital (including cohesion, reciprocity, social ties, social control, and reproductive norms) as well as measures of social disorder (perceptions of safety) and material resources (food insecurity) are related to the odds of low birth weight birth.

Specifically, we hypothesize that increased social reciprocity (because it measures helping) will predict lower rates of low birth weight. We predict that social cohesion, on the other hand, will play a neutral role in low birth weight outcomes, since it tends to measure how similar one feels to one's neighbors as opposed to the help, advice, or guidance that comes from social interactions. Finally, we hypothesize that measures of perceived violence or nutrition access as captured by low perceived safety of the neighborhood and higher levels of food insecurity may have a significant association with increased low birth weight outcomes.

Methods

Data

California Vital Records Data. Birth certificate data were obtained from the California Department of Public Health for the state of California between 2000 and 2004 to coincide with L.A.FANS data collection between 2000 and 2002. We included only the 746,934 singleton births for which either Census tract or address data existed and which allowed us to produce an accurate geocode that placed the mother's residence in one of LA County's 2,054 Census tracts. We used ArcGIS Desktop 9.3 for address geocoding (ESRI, 2009). Infants with any congenital malformation (trisomies, cleft palate, and congenital heart defect) were also excluded (n= 12,968), since these genetic defects are commonly related to low birth weight (Dolan et al., 2007; Honein et al., 2008; Khoury, Erickson, Cordero, & McCarthy, 1988). We further restricted these records to include only those for which the mother's residence at the time of birth was in one of the 90 2000 Census tracts which were derived from the 65 L.A.FANS 1990 Census tracts. These 90 Census tracts constitute approximately 4% of the 2,054 Census tracts in LA County, and the population of births we can include is also therefore dramatically reduced, with an additional 679,946 births excluded. Ultimately, 41,564 singleton births were matched to the 65 Census tracts in the L.A.FANS survey.

Dependent variable. Infant weight in grams was used to create a categorical outcome variable for low birth weight. Low birth weight was defined as birth weight less than 2500g, regardless of gestational age. While the use of a categorical outcome, as opposed to continuous birth weight in grams, significantly diminishes the amount of information contained in the outcome variable, we deemed this appropriate for several reasons. Preliminary analyses suggested that the variation between neighborhoods using weight in grams was relatively small, but the burden of low birth weight (e.g., low birth weight rate) showed more variation between neighborhoods. In addition, though low birth weight seems to be an arbitrary clinical cutoff, it does have clinical importance in that increases in weight for those infants weighing less than 2,500 grams are associated with more substantial improvement in outcomes than for those infants weighing less than 2500g (Sastry & Hussey, 2002).

Individual-level independent variables. Individual-level covariates were derived from vital records data for each of the births in the sample. Infant sex and congenital anomalies were coded as binary variables. Mother's age was mean-centered and used in models as both a discrete continuous measure and a quadratic term (mean-adjusted prior to squaring). Mother's race was coded as a set of binary variables indicating non-Hispanic White, non-Hispanic Black, Asian/Pacific Islander, and Hispanic (any race). Mother's education was coded as a mean-centered discrete continuous variable, with missing education re-coded to zero; categorical analyses using up to 7 educational categories with missing education as a separate category indicated little difference between this group and those mothers reporting no education.

Vital records also included medical history and visit data for the pregnancy, including parity, which we recoded to nulliparous vs. multiparous. Complications of pregnancy were recoded to a count variable indicating the number of complications, which was mean-centered. Insurance types included MediCal (California Medicaid), private payers (including Blue Cross/Blue Shield plans and HMO/capitated plans), other government payers (including Champus/Tri-care (active duty military and dependents), Veteran's Administration, Medicare, and Indian Health Service), self-pay, and no or unknown coverage. We include prenatal care insurance type because it is likely to represent latent income and employment differences between the racial and ethnic groups.

Gestational age, initiation of prenatal care, and number of prenatal care visits were combined to create scores for the Kotelchuck adequacy of prenatal care utilization index (Kotelchuck, 1994). The index is scored according to initiation of prenatal care (first trimester vs. any other time) and the proportion of visits received compared to the number of visits recommended by the American College of Obstetrics and Gynecology (ACOG) for the given gestational age at delivery (i.e., given the duration of pregnancy at delivery, how many visits would be expected if the ACOG guidelines were followed precisely) (American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2007). If a woman receives no prenatal care, or if prenatal care begins later than the 4th month of pregnancy, care is described as "inadequate." Inadequate prenatal care also includes women whose care began in the first trimester, but who had fewer than 50% of the recommended number of visits for the given duration of pregnancy. "Intermediate" prenatal care includes any woman whose prenatal care began in the first trimester, but who had only 50-80% of the recommended visits relative to gestational age. "Adequate" prenatal care describes those women whose care began in the first trimester and had 80-110% of the recommended visits relative to duration of pregnancy. Finally, "adequate plus" care characterizes those pregnancies for which care began in the first trimester and for which the proportion of recommended vs. observed visits exceeds 110%. Though birth certificate reliability and validity is questionable, especially for prenatal care utilization, the birth certificate provides a more reliable source of prenatal care utilization when compared to surveys of providers or mothers (Penrod & Lantz, 2000).

Analyses were adjusted for year and season of birth using fixed effects, as well as for geocoding accuracy (see Appendix A for details on geocoding) and a best-approximation for gestational age accuracy (e.g., late entry to prenatal care). None of these adjustments changed the outcomes of the models.

L.A.FANS Survey Data. The Los Angeles Family and Neighborhood Survey (LAFANS) was administered by RAND between 2000 – 2002 (Wave 1), and is based on a stratified random sample of 65 neighborhoods (Census tracts) in Los Angeles County (Sastry, Ghosh-Dastidar, Adams, & Pebley, 2006). Poor neighborhoods were oversampled. In Wave 1, an average of 41 households were randomly selected and interviewed within each neighborhood, including an oversample of households with children under 18. Within each household, both adults and children were sampled and interviewed. Response rates for adult-alone respondents were 85%, primary care givers, 89%, and children, 87%. A randomly-sampled adult (RSA) was interviewed for each household, as well as a randomly-sampled child (RSC) for each household with children under 18. In households where an RSC was interviewed, the primary care giver for the child was also interviewed using the same instruments as those for the randomly-sampled adult (in some cases, these two individuals are the same). This analysis is restricted to responses on the adult survey module as provided by the RSA (regardless of whether this person was also the primary care giver for the RSC) sampled households (survey responses for other adults and emancipated minors are excluded), resulting in 2,619 respondents (1 per household) in 65 tracts (neighborhoods). Each tract had a mean of 40 respondents (u = 40.29, SD = 6.08), with a minimum of 27 and a maximum of 58 respondents. Sastry et al. report that Cenus tracts are a good approximation of neighborhoods because they roughly correspond to respondents' understandings of neighborhood size, and tracts are delineated along natural boundaries (unlikely to cross major streets, bodies of water, etc.) (2006).

Adult respondents were asked to gauge their neighborhoods based on familiarity with neighbors, sense of safety, acts of reciprocity/helping, and acts of social control (e.g., preventing teenagers from spray-painting graffiti). Combinations of these questions were used to create neighborhood-level scales based on the mean response plus a random neighborhood-level error term. Table 3-1 provides the items, mean response by tract, and groupings for each scale. Unless otherwise specified, responses were given on a Likert scale from 1 to 5, with 1 being most positive.

An ecometric approach was used to create scales from these items. Ecometrics applies principles of psychometric scale validation (internal validity and reliability) to ecological data such as the neighborhood social capital data obtained in LAFANS (Raudenbush & Sampson, 1999; Mujahid et al., 2007). In the case of these data, items that constitute a scale are nested within individuals, but individuals are also nested within neighborhoods (tracts, sampling clusters, etc.). To produce accurate scale scores, a three-level hierarchical model was fit to estimate each scale at the neighborhood level. A person-item dataset (similar to a longitudinal person-wave or person-year dataset) was constructed for each scale; item dummies were used to predict item response as detailed in the following nested model, where *i* represents Item I, *j* represents person J, and *k* represents neighborhood K, and *n* represents the total number of items in the scale:

Level 1 (Item) Model:

$$\text{Response}_{ijk} = \pi_{0jk} + \pi_{1jk}(Item1_{ijk}) + \pi_{2jk}(Item2_{ijk}) + \ldots + \pi_{(n-1)jk}(Item(n-1)_{ijk}) + e_{ijk}$$

Level 2 (Person) Model:

$$\begin{aligned} \pi_{1jk} &= \beta_{00k} + r_{0jk} \\ \pi_{2jk} &= \beta_{10k} \\ \pi_{3jk} &= \beta_{20k} \\ \pi_{(n-1)jk} &= \beta_{(n-1)0k} \end{aligned}$$

Level 3 (Neighborhood) Model:

$$\begin{aligned} \beta_{00k} &= \gamma_{000} + u_{00k} \\ \beta_{10k} &= \gamma_{100} \\ \beta_{20k} &= \gamma_{200} \\ \beta_{(n-1)0k} &= \gamma_{(n-1)00} \end{aligned}$$

These models were weighted using a probability weight at level 2 (person level) which represented each respondent's probability of being selected given that their neighborhood had been selected, which was then response-adjusted so that the sum of the weights equaled the number of respondents. Though some debate still exists regarding the appropriate weighting for multi-level models of complex, clustered survey data, we used the strategy described by Chantala et al. to create the person- and tract-level weights (2006). Fully adjusted person-level weights available from LAFANS (which account for both respondent and tract-level probability of selection and population adjustments) were divided by a tract-specific probability weight representing the probability of tract selection and adjustment for the population of LA County. These tract-specific probability weights were later adjusted by Sastry to account for the birth population (as opposed to the adult population). These birth-adjusted tract weights were used in the final 2-level HLM models described below.

The score on a given scale is created for each neighborhood by adding the tract-level mean scale score (of respondents in neighborhood *k*) (i.e., the neighborhood-level intercept) and the residual u00k for that neighborhood. Residuals were estimated using empirical Bayes estimation techniques, which results in "shrinkage estimators" (Raudenbush & Bryk, 2002, p. 159); the empirical Bayes estimators decrease the variance in the scale by biasing less reliable values towards the mean of similar neighborhoods (e.g., weighting more reliable estimates more heavily). Because the final scales are used as predictor variables rather than outcomes in the analytical models, the reduction of raw variance offered by an empirical Bayes estimator (as compared to using a more traditional OLS estimator) is more desirable. However, given the relatively large number of responses per neighborhood, this shrinkage effect is not likely to have produced considerable additional reductions in variance.

Statistical Models

After the neighborhood level scales were created, we assessed the association between individual level variables and neighborhood level scales and low birth weight by fitting a series of two-level hierarchical generalized linear models with a logit link function (Bernoulli models) (Raudenbush & Bryk, 2002). As previously mentioned, these models were weighted at the tract level using a tract-specific probability weight adjusted for the population of births in LA County in 2002. We first fit an unconditional model (an empty model with a random effect at the tract level) to determine the baseline variance in low birth weight at the neighborhood level, which allows for subsequent estimation of the proportion of variance explained by additional covariates. Intraclass correlations for the models predicting low birth weight were not calculated because multi-level logit models have a fixed, heteroskedastic variance at level 1 which obfuscates the interpretation of these values (Raudenbush & Bryk, 2002). Subsequent conditional models (i.e., intercepts-as-outcomes) were then used to measure the association between each neighborhood scale and low birth weight without individual level predictors; a second set of models then adjusted for individual (level 1) predictors. To assess whether scales derived from the LAFANS survey might affect mothers of different races differently, we fit an intercepts and slopes as outcomes (cross-level interaction) model which allows the effect of neighborhood level factors to vary across mothers' race.

Results

The results of the 3-level HLM models to create the 9 scales we tested are provided in Table 3-2. We report both the reliability and the intraclass correlation (ICC) for each scale, with the exception of safety and food insecurity, which were modeled using a generalized linear model with a logit link function, thus precluding the calculation of the ICC. With the exception of reproductive norms and social ties, each scale has >0.70 reliability, suggesting high within-neighborhood correlation on responses to the scale items across respondents from each neighborhood. The ICC, which represents the variation between neighborhoods, is in the .03-.10 range for each scale. While low, these ICC scores do not preclude the use of these neighborhood level covariates (Mujahid et al., 2007), especially since chi-squared tests for each scale led us to reject the null hypothesis that there was no significant between-tract variation for each scale. Social ties scores quite low on ICC however, in addition to low reliability; therefore, this scale was not used in subsequent analyses.

The unadjusted and adjusted odds ratios for each scale illustrate the association each has with the odds of low birth weight. Each scale was used as the single level-2 covariate in models with no covariates (unadjusted) and individual level covariates (adjusted). Neighborhood scores on each scale significantly predict an increase in the odds of low birth weight, with the exception of reproductive norms and social ties. This evidence, in conjunction with ICC and reliability scores, led us to also exclude reproductive norms from subsequent analyses. After adjusting for individual level factors (infant sex, maternal age, race, nativity, education, parity, complications of pregnancy, medical insurance, and prenatal care), however, each of the scales' predictive value drops; none of the scales are significantly associated with low birth weight odds (with the exception of reproductive norms; as mentioned however, this predictor was not robust in the ecometric testing and was dropped from further analyses). The adjusted models of each scale predicting low birth weight, however, do not allow the impact of the neighborhood level scale to vary by mother's race or nativity.

Table 3-3 provides the results for a cross-level interaction model (i.e., an intercepts-and-slopes as outcomes model), which allows the neighborhood scales to vary across mother's race and nativity. While many of the associations between neighborhood scales and low birth weight odds remain non-significant, three associations become quickly apparent. First, for foreign-born mothers (of any race), both increasing intergenerational closure (that is, parents' knowledge of children's whereabouts, friends, etc) and increasing reciprocal exchange (neighbors helping out and/or doing favors for one another) are associated with a reduction in the odds of low birth weight (OR = 0.427, 95% CI = 0.259,0.706; OR = 0.34, 95% CI = 0.162, 0.712, respectively). Secondly, for US-born Hispanic mothers, reciprocal exchange actually increases the odds of low birth weight (OR = 2.952, 95% CI = 1.012, 8.610).

Though we hypothesized that food insecurity and safety concerns might be important for mothers of any race or nativity status, these results suggest that food insecurity does not predict increased odds of low birth weight for any group. Furthermore, perceptions of decreasing safety are associated with increased odds of low birth weight only for US-born White mothers (the "remainder" in the cross-level interaction) (OR = 1.68, 95% CI = 1.124, 2.445).

Discussion

These models suggest that measures of neighborhood reciprocal exchange, neighborhood intergenerational closure, and neighborhood perceptions of safety may each be associated with low birth weight outcomes independent of mothers' individual risk factors. Importantly, each construct is associated with birth outcomes for different racial and ethnic groups in different ways. Previous analyses with the LA County vital records data have suggested that living in relative racial isolation with other co-ethnics who speak predominantly Spanish is potentially protective against low birth weight for foreign-born Hispanic women in LA County. Though this analysis does not control for the type of neighborhoods in which each mother lives, (e.g., reciprocity could be significantly associated with reduced low birth weight for foreign-born mothers in any neighborhood, or only in neighborhoods with high proportions of foreign-born residents), we can speculate that many foreign-born women live in neighborhoods with other foreign-born residents. It may be that the constructs of neighborhood-level reciprocity and intergenerational closure capture the characteristics of so-called ethnic enclaves that are most closely associated with protection from low birth weight outcomes. For instance, a neighborhood with high reciprocity on average is one in which a pregnant woman may feel as though the culture of the neighborhood lends itself to asking for help if needed, or even to receiving help when it is not asked (e.g., a neighbor crossing the street to help with groceries, or bringing food when a newborn arrives). The sense that neighbors take actions to help one another could provide peace of mind and a buffer against stressors that predispose women to preterm delivery or intrauterine growth restriction.

Alternatively, there are a few reasons why reciprocity could be associated with increased low birth weight risk for US-born Hispanic women. Previous analyses in this dissertation suggest that the neighborhood types which confer advantage (or are neutral) for foreign-born Hispanic women (e.g., Hispanic-White isolated, high proportions of foreign-born non-English speakers) are actually associated with higher odds of low birth weight birth among US-born Hispanic women. If high neighborhood reciprocity is a hallmark of so-called Hispanic immigrant enclaves, then it may be associated with poorer outcomes for US-born Hispanic women by virtue of association rather than causation. Though spatial assimilation theory models suggest that the enclave effect for US-born women who remain in immigrant neighborhoods should be positive, both these results and those of the previous chapter suggest that may not be the case with regard to birth outcomes.

Operating on the assumption stated above that high levels of reciprocity may characterize neighborhoods with higher proportions of foreign-born women, it may be that the disadvantages for US-born Hispanic women living in these neighborhoods cannot be overcome by increased reciprocity; the higher levels of reciprocity may not directly cause increased low birth weight, but occur in neighborhoods which put US-born Hispanic women particularly at risk.

On the other hand, it is possible that US-born Hispanic women living in neighborhoods with high reciprocity (and potentially high expectations of reciprocity) may find themselves somewhat stretched by neighbors' and family members' demands. This may be an example of Portes' "negative consequences" of social capital, wherein the demands of high levels of bonding social capital actually have detrimental impacts on health (1998). Typically this association has been found in mental health outcomes, but here we see a potential role in reproductive outcomes. Because of their familiarity with life in the United States, US-born Hispanic women may have better luck navigating the cultural, linguistic, political, and economic systems of the US than their recently-immigrated neighbors, making them important resources for the community. If help or reciprocity is expected, these women may feel overburdened by the demands of a liaison or ambassador role for their community; this "ambassador stress" may be detrimental for birth outcomes, including low birth weight. This scenario is qualitatively similar to one raised by Patillo-McCoy regarding the responsibility middle-class Black women may feel to families and friends who reside in poorer neighborhoods, and the strain that such ties can place on a family (1999).

Finally, perceptions of a neighborhood's safety, as measured by residents' perceived safety of walking alone at night and exposure to crime, is significantly associated with increased odds of low birth weight birth for US-born White women. Research has found that resident perceptions of a neighborhood's safety can be driven by the racial composition of that neighborhood, in addition to – or in spite of – objective measures of crime events (Elo et al., 2009; Mujahid et al., 2007). Higher concentrations of people of color tend to suppress perceived safety, even when objective crime data do not support the subjective assessment (Elo et al., 2009). In addition, perceptions of neighborhood crime seem to matter more for pregnancy outcomes than do the actual objective measures of crime or violence (Auger et al., 2008). If living in a neighborhood with a predominance of people of color elevates Whites' perceived risk of violence in that neighborhood, it could be that pregnant White women in these neighborhoods would have similar perceptions, increasing their exposure to stress during pregnancy.

In the sample obtained by LAFANS, only a small number of tracts were considered "predominantly White" (9 of 65 tracts). Nearly half were predominantly Hispanic (30 of 65 tracts), and an additional 17% (11 of 65) were considered "White with other race/ethnic co-occupancy." Given the relatively low tolerance of Whites in LA for (poor) Hispanic, and especially Black, neighbors, it is possible Whites would more frequently agree to feeling unsafe while walking if they lived in neighborhoods with larger numbers of people of color. However, the LAFANS data suggest the opposite – in weighted cross-tabulations, White respondents were less likely to endorse the "somewhat dangerous" and "extremely dangerous" items in both predominantly White and non-White neighborhoods. This suggests that the perceived safety of a neighborhood may not be affected by a compositional bias; Whites' perceptions were not significantly different from the perceptions of other race or ethnicity respondents.

In terms of White women's low birth weight outcomes, however, it may be that these women feel greater stress than women of color when faced with a neighborhood that is generally perceived as unsafe by the population. Though this hypothesis has not been tested, it is possible that in neighborhoods that are generally considered (by all residents, regardless of race) to be unsafe, whites in these neighborhoods perceive them to be less safe than do other residents in the neighborhood. If this is the case, then white women living in neighborhoods with lower perceived safety may be particularly vulnerable to stresses created by perceived lack of safety (constant watchfulness/wariness and concomitant elevated cortisol levels) and that stress could negatively impact rates of low birth weight among white women in unsafe neighborhoods.

Limitations.

As with most inquiries into the contextual factors related to birth outcomes, this investigation is both observational and cross-sectional. Though the purported mechanism by which many neighborhood effects translate into birth outcomes is via chronic stress exposure, the length of a mother's residence at the address listed on the birth certificate cannot not be determined. More longitudinal data on neighborhoods are becoming available, but prospective studies of women's pregnancy outcomes with detailed residential history would allow us to make significant strides in understanding neighborhood effects on birth outcomes. It is difficult, in the absence of these data, to make a distinction between selection bias/compositional effect (that is, that women with a lower propensity for low birth weight selectively reside in neighborhoods with higher levels of safety, for example) and a contextual effect of neighborhood characteristics.

In addition, mobility between neighborhoods presents a challenge, as lower-income individuals especially tend to have less stable housing. If pregnancy outcomes are dependent upon some length of exposure, or on cumulative exposure, to neighborhood circumstances, then cross-sectional data cannot provide definitive evidence of a causal relationship between neighborhood social capital and birth outcomes. However, researchers have found that, commonly, individuals form disadvantaged neighborhoods tend to relocate to neighborhoods with similar conditions (South & Crowder, 1998; South, Crowder, & Chavez, 2005). Of particular importance to this study, researchers have found that because contextual exposures are similar across time, for children at least, there are not appreciable differences between cross-sectional and longitudinal treatments of neighborhood circumstances (Jackson Mare 2007).

The association between neighborhood scales measuring social cohesion, food resources, or perceived safety and low birth weight outcomes is particularly dampened in these models. Previous research has found somewhat more robust associations with neighborhood scales and birth outcomes (M. Jones, Pebley, & Sastry, 2011; Mujahid et al., 2007). It is possible that sample size is an issue in terms of the multiple subdivisions required by cross-level interactions, though with a relatively large number of clusters and respondents within clusters, the neighborhood scales should be robust. It is also possible that these measures of social cohesion, material resources, and safety do not capture relevant constructs for pregnancy outcomes among women in Los Angeles County, or that the admittedly low variation between neighborhoods on the scales is suppressing any associations. However, this is the first study to attempt to use ecometric measures from a detailed neighborhood survey to predict population-wide birth outcomes; as such, it offers unique insight into the potential importance of generational closure and neighborhood reciprocity. In particular, the ability to more objectively assess the neighborhood circumstances via survey respondents whose outcomes are not part of the study is particularly compelling. This study is not hampered by source bias, and it provides a more objective view of how the population of residents perceives their neighborhood. Furthermore, this is the first such study to include multiple racial and ethnic groups and attempt to discern any differences between them with regard to the types of social capital that might be important.

Conclusions

Overall, we cautiously interpret these results as evidence for divergence in the experiences of native born and foreign-born Hispanic women with regard to how social capital, and in particular, neighborhood reciprocity, is associated with low birth weight outcomes. Though Hispanic women have low rates of low birth weight overall, their outcomes begin to worsen (on a population level) with longer residence in the US (Landale et al., 2000); it is worth noting the disparate effects that neighborhood of residence may have for recently immigrated vs. native born women.

African American women's outcomes, however, are not associated with any of the tested constructs, and for black women in LA County, at least, it seems that these measures do not capture the unique or differential exposures to which Osypuk and Acevedo-Garcia alluded (2008). Again, it is certainly possible that weak constructs have obscured the relationship between detailed perceptions of neighborhood social circumstances and low birth weight outcomes.

A second possibility beyond weak scale construction is that these social capital scales may in fact be more important for foreign-born women with regard to health and birth outcomes – as they arrive in the United States, these women may be drawn to neighborhoods with higher proportions of extended family members, or individuals from the same towns, villages, or cities from which they are emigrating. Seeking out social support makes the transition to a new country easier and facilitates the difficult process of adjusting to a completely new way of life. If foreign-born women are self-selecting into neighborhoods with higher social cohesion, they may also be more likely to reap the benefits in terms of pregnancy outcomes. The opposite may be true for US-born Hispanic women, though, in the sense that they may find these neighborhoods stressful in a number of ways.

Further exploration of these issues, including the importance of safety, and the future inclusion of physical as well as subjective measures of social capital, physical disorder, etc., will help to illuminate the ways in which people interact with their spaces and with each other in those spaces. We have begun to shed light on a small element of these interactions and how they might be important for low birth weight outcomes among foreign born and Hispanic women in Los Angeles County.

Table 3-1. Individual LAFANS survey items, Los Angeles County 2000-2002

Scale Name/Items	**Weighted Tract Average**	**Standard Error**	**Minimum Score**	**Maximum Score**
Cohesion				
All things considered, how satisfied are you with your neighborhood as a place to live?	2.526	0.164	1.140	3.158
This is a close-knit neighborhood	2.748	0.178	2.044	3.821
People around here are willing to help their neighbors	2.422	0.138	1.733	3.065
People in this neighborhood generally don't get along with each other[a]	3.590	0.139	2.950	4.209
People in this neighborhood do not share the same values[a]	4.067	0.068	3.794	4.171
People in this neighborhood can be trusted	2.849	0.167	1.829	3.525
Intergenerational Closure				
There are adults in this neighborhood children can look up to	2.774	0.168	1.741	3.575
Parents in this neighborhood know their children's friends	2.413	0.115	1.815	3.231
Adults in this neighborhood know who the local children are	2.608	0.125	1.825	2.865
Parents in this neighborhood generally know each other	2.302	0.126	1.978	2.900
You can count on adults in this neighborhood to watch out that children are safe and do not get into trouble	2.465	0.139	1.800	3.100
Social Control				
If a group of neighborhood children were skipping school and hanging out on a street corner, how likely is is that your neighbors would do something about it?	2.764	0.222	1.644	3.474
If some children were spray-painting grafitti on a local building, how likely is it that your neighbors would do something about it?	2.086	0.128	1.089	3.163
If a child was showing disrespect to an adult, how likely is it that people in your neighborhood would scold that child?	2.704	0.177	2.000	3.226
Social Ties[c]				
How many of your relatives or in-laws live in your neighborhood?	1.525	0.067	1.086	1.938
How many of your friends live in your neighborhood?	1.990	0.126	1.512	2.349
About how many adults do you recognize or know by sight in this neighborhood?	2.700	0.082	2.194	2.978
In the past 30 days, how many of your neighbors have you talked with for 10 minutes or more?	2.715	0.098	1.875	2.806
How close do you feel to the neighbor you are friendliest with?	1.712	0.106	1.647	2.780
Safety				
While you have lived in this neighborhood have you or anyone in your household had anything stolen or damaged inside or outside your home, including your cars or vehicles parked on the	0.420	0.064	0.189	0.658
How safe it is to walk around alone in your neighborhood after dark?[b]	2.202	0.123	1.256	3.075
Reciprocity				
About how often do you and people in your neighborhood do favors for each other?	2.016	0.138	1.556	2.784
When a neighbor is not at home, how often do you and other neighbors watch over their property?	1.944	0.163	1.182	3.200
How often do you and other people in the neighborhood ask each other advice about personal things such as child rearing or job openings?	2.337	0.185	2.294	3.270
Food Insecurity				
How far away is the grocery store you normally go to to buy groceries?[b]	2.083	0.158	1.167	3.541
In the past 12 months, was there ever a time when anyone in your household didn't get enough to eat because there wasn't enough money for forrd?	0.293	0.066	0.000	0.200
In the past 12 months, have you ever gotten emergency food from a church, food pantry, food bank, or soup kitchen?	0.039	0.044	0.000	0.179
Civic/Organizational Participation				
In the past 12 months, have you participated in a:				
Neighborhood or block organization meeting?	0.087	0.039	0.000	0.481
Business or civic group (Masons, Elks, Rotary Club)?	0.007	0.007	0.000	0.372
Nationality or ethnic pride club?	0.074	0.035	0.000	0.156
A local or state political organization?	0.020	0.011	0.000	0.233
Volunteered in a local organization?	0.214	0.057	0.000	0.556
Veteran's group?	0.013	0.009	0.000	0.098
Labor union?	0.013	0.009	0.000	0.122
Literary, art, study, or discussion group?	0.071	0.040	0.000	0.370
Fraternity, sorority, or alumni group?	0.000	0.000	0.000	0.268
Are you a member of a church, synagogue, mosque, temple, or other religious group?	0.493	0.070	0.050	0.769
Reproductive Norms				
How much do you approve of the following:				
A teenage girl has a baby without being married	3.974	0.150	3.667	4.372
A woman in her twenties has a baby without being married	3.225	0.158	2.759	4.023
A man in his twenties fathers a child without being married to the baby's mother	3.278	0.154	2.892	4.125
A man and a woman live together before they decide about getting married	2.717	0.193	1.857	3.128
A man and a woman decide to live together even though they do not intend to get married	3.072	0.153	2.114	3.615

a - Reverse coded
b - Recoded as binary to match other items in scale
c - Likert categories (None = 1, Most or all = 4)

Table 2. Intraclass correlation, reliability, and predictive value of LAFANS neighborhood scales, LA County 2000-2004

						Unadjusted OR predicting LBW			Adjusted OR[a] predicting LBW		
Scale	**No. Items**	**Weighted Tract Mean**	**Standard Error**	**ICC (ρ)**	**Reliability (λ)**	**OR**	**p**	**95% CI**	**OR**	**p**	**95% CI**
Cohesion	6	2.527	0.020	0.047	0.875	1.494	*	[1.055,2.114]	0.987		[0.636,1.532]
Social Control	3	2.594	0.036	0.100	0.817	1.333	*	[1.065,1.668]	1.073		[0.812,1.417]
Intergenerational Closure	5	2.413	0.027	0.102	0.875	1.432	**	[1.117,1.835]	1.248		[0.906,1.719]
Social Ties	5	2.094	0.003	0.003	0.331	0.195		[0.016,2.435]	1.029		[0.059,18.017]
Reciprocity	3	2.786	0.024	0.061	0.723	1.696	**	[1.194,2.408]	1.434		[0.937,2.194]
Organizational Participation	10	0.387	0.007	0.037	0.864	0.112	**	[0.030,0.421]	0.240		[0.044,1.309]
Reproductive Norms	5	3.068	0.016	0.030	0.559	1.415		[0.735,2.725]	2.068	*	[1.017,4.206]
Food Insecurity	3	-3.648	0.093		0.747	1.133	*	[1.021,1.257]	0.987		[0.872,1.117]
Fear for Safety	2	-1.087	0.052		0.833	1.182	**	[1.064,1.313]	1.140		[0.996,1.306]

a - Adjusted for individual level factors: infant sex, maternal age, education, race, parity, complications, insurance, and prenatal care status

Exponentiated coefficients; 95% confidence intervals in brackets

* p<0.05, ** p<0.01, *** p<0.001

Table 3-3. Odds ratios of HGLM using LAFANS social capital scales for predicting low birth weight outcomes by mother's race, Los Angeles County 2000-2004

	Scale								
	Cohesion			Intergenerational Closure			Social Control		
	OR	p	CI	OR	p	CI	OR	p	CI
Cross-level interaction with Mother's Race & Nativity									
Black	0.846		[0.216,3.303]	0.572		[0.212,1.540]	0.733		[0.288,1.863]
Asian/Pacific Islander	1.234		[0.347,4.383]	1.339		[0.556,3.225]	0.972		[0.424,2.230]
Hispanic	1.472		[0.491,4.418]	1.211		[0.560,2.622]	0.923		[0.455,1.872]
Foreign-born (any race)	0.519		[0.249,1.081]	0.427	***	[0.259,0.706]	0.694		[0.433,1.114]
Scale score (White, US born)	1.255		[0.425,3.702]	1.904		[0.895,4.049]	1.513		[0.765,2.989]
Individual Level Predictors									
Male Infant	0.886	*	[0.804,0.976]	0.885	*	[0.803,0.976]	0.886	*	[0.805,0.977]
Mother's Age	1.011	*	[1.002,1.021]	1.012	**	[1.003,1.022]	1.011	*	[1.002,1.020]
Mother's Age-2	1.001	*	[1.000,1.002]	1.001		[1.000,1.002]	1.001	*	[1.000,1.002]
Black Mother	3.541		[0.109,115.465]	8.796		[0.778,99.490]	5.059		[0.429,59.619]
Asian/Pacific Islander mother	0.933		[0.040,22.036]	0.774		[0.094,6.377]	1.712		[0.203,14.415]
Hispanic Mother	0.426		[0.027,6.709]	0.685		[0.107,4.381]	1.382		[0.224,8.523]
Mother Foreign-born	4.882		[0.741,32.166]	7.386	**	[2.109,25.870]	2.369		[0.680,8.255]
Mother's Education	0.960	***	[0.941,0.978]	0.960	***	[0.941,0.978]	0.960	***	[0.942,0.979]
Nulliparous	1.505	***	[1.346,1.684]	1.513	***	[1.352,1.692]	1.504	***	[1.345,1.682]
Pregnancy Complications	1.765	***	[1.657,1.880]	1.763	***	[1.655,1.877]	1.764	***	[1.657,1.879]
Medicaid Insurance	1.118		[0.988,1.266]	1.112		[0.983,1.259]	1.117		[0.988,1.264]
Self-Pay Insurance	1.408	*	[1.027,1.931]	1.404	*	[1.024,1.926]	1.417	*	[1.033,1.942]
Other gov't Insurance	0.483		[0.167,1.402]	0.485		[0.167,1.410]	0.484		[0.167,1.404]
Unknown/No Insurance	3.751	***	[2.539,5.543]	3.726	***	[2.520,5.509]	3.746	***	[2.536,5.535]
Inadequate Prenatal Care	1.835	***	[1.580,2.131]	1.833	***	[1.578,2.129]	1.835	***	[1.580,2.131]
Intermediate Prenatal Care	0.890		[0.753,1.053]	0.889		[0.751,1.052]	0.890		[0.753,1.053]
Overadequate Prenatal Care	3.389	***	[3.012,3.814]	3.393	***	[3.014,3.819]	3.389	***	[3.011,3.814]
Intercept	0.011	**	[0.001,0.162]	0.011	**	[0.001,0.162]	0.004	***	[0.001,0.025]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001

	Scale								
	Reciprocity			Food Insecurity			Fear for Safety		
	OR	p	CI	OR	p	CI	OR	p	CI
Cross-level interaction with Mother's Race & Nativity									
Black	1.599		[0.413,6.183]	0.956		[0.661,1.382]	0.657		[0.427,1.010]
Asian/Pacific Islander	1.769		[0.538,5.823]	1.382		[0.952,2.005]	0.827		[0.525,1.303]
Hispanic	2.952	*	[1.012,8.610]	1.113		[0.822,1.507]	0.697		[0.470,1.034]
Foreign-born (any race)	0.340	**	[0.162,0.712]	0.958		[0.776,1.182]	0.897		[0.713,1.129]
Scale score (White, US born)	1.404		[0.506,3.897]	0.917		[0.679,1.239]	1.658	*	[1.124,2.445]
Individual Level Predictors									
Male Infant	0.886	*	[0.804,0.976]	0.887	*	[0.805,0.978]	0.887	*	[0.805,0.978]
Mother's Age	1.012	*	[1.003,1.021]	1.010	*	[1.001,1.020]	1.011	*	[1.002,1.020]
Mother's Age-2	1.001	*	[1.000,1.002]	1.001	*	[1.000,1.002]	1.001	*	[1.000,1.002]
Black Mother	0.612		[0.014,26.868]	2.069		[0.550,7.787]	1.390		[0.828,2.334]
Asian/Pacific Islander mother	0.336		[0.012,9.106]	5.496	*	[1.352,22.337]	1.281		[0.718,2.284]
Hispanic Mother	0.056		[0.003,1.075]	1.726		[0.549,5.423]	0.736		[0.447,1.212]
Mother Foreign-born	18.571	**	[2.310,149.310]	0.776		[0.360,1.674]	0.818		[0.627,1.068]
Mother's Education	0.961	***	[0.943,0.980]	0.960	***	[0.942,0.978]	0.962	***	[0.943,0.980]
Nulliparous	1.504	***	[1.345,1.683]	1.496	***	[1.338,1.673]	1.504	***	[1.345,1.682]
Pregnancy Complications	1.769	***	[1.661,1.885]	1.769	***	[1.660,1.885]	1.764	***	[1.656,1.879]
Medicaid Insurance	1.112		[0.983,1.258]	1.125		[0.994,1.273]	1.109		[0.980,1.255]
Self-Pay Insurance	1.426	*	[1.040,1.955]	1.433	*	[1.046,1.964]	1.423	*	[1.038,1.951]
Other gov't Insurance	0.489		[0.169,1.420]	0.490		[0.169,1.421]	0.486		[0.167,1.411]
Unknown/No Insurance	3.781	***	[2.557,5.590]	3.790	***	[2.565,5.600]	3.735	***	[2.527,5.520]
Inadequate Prenatal Care	1.834	***	[1.579,2.131]	1.835	***	[1.580,2.131]	1.832	***	[1.578,2.128]
Intermediate Prenatal Care	0.891		[0.753,1.054]	0.891		[0.753,1.054]	0.891		[0.753,1.054]
Overadequate Prenatal Care	3.379	***	[3.002,3.803]	3.384	***	[3.007,3.809]	3.379	***	[3.002,3.804]
Intercept	0.007	***	[0.000,0.124]	0.014	***	[0.004,0.044]	0.035	***	[0.021,0.059]

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001

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CHAPTER 4:

Preconception Care: The Best Way Forward for Eliminating Racial Inequities in Low Birth Weight?

Introduction

Since the 2006 publication of "Recommendations to Improve Preconception Health and Health Care--United States" by the US Centers for Disease Control and Prevention (CDC), a growing body of work has been dedicated to the dissemination and assessment of these recommendations. In particular, these articles seek to encourage clinicians and public health professionals to integrate preconception care into general primary and preventive practice for "every woman, every time" (Moos, 2006). The development of preconception care stems from the knowledge that some risks to the optimal growth and development of the fetus (some of which may be amenable to change) exert their greatest influence early in pregnancy or prior to conception. Logically, if intervention can mitigate these risks before the initiation of pregnancy, some number of adverse outcomes could be avoided. Under these auspices, the joint CDC/Agency for Toxic Substances and Disease Registry (ATSDR) Preconception Care Work Group and Select Panel on Preconception Care developed their seminal report outlining specific guidelines and recommendations for preconception health care in the United States. The stated goals of the report and the recommendations it outlined were to:

> 1) improve the knowledge and attitudes and behaviors of men and women related to preconception health;
> 2) assure that all women of child-bearing age in the United States receive preconception care services (i.e., evidence-based risk screening, health promotion, and interventions) that will enable them to enter pregnancy in optimal health;

3) reduce risks indicated by a previous adverse pregnancy outcome through interventions during the interconception period, which can prevent or minimize health problems for a mother and her future children; and

4) reduce the disparities in adverse pregnancy outcomes. (Johnson et al., 2006, p. 1).

In this commentary, we seek to appraise the literature to date regarding the justification for, implementation of, and assessment of preconception care guidelines. Though we include each of the four preconception care aims in our examination of the literature and discourse, we have particular interest in the CDC working group's 4th stated goal: reducing disparities in adverse pregnancy outcomes. Because problems related to low birth weight and short gestation are the leading cause of infant mortality for children born to black and Hispanic mothers, and because disparities in low birth weight and short gestation drive disparities in birth outcomes, we give special consideration to the ways in which the recommendations published by the CDC and other groups might contribute to reductions in the prevalence of low birth weight and prematurity. Specifically, we will address the following questions:

1) What is the evidence for the effectiveness of preconception care for reducing adverse outcomes when applied to the entire female population, especially as it relates to reducing low birth weight?

2) How are the preconception care recommendations – which emphasize health care access, health education, and health behaviors – situated within the literature underscoring the social determinants of health (income, education, employment, social environment, etc) and low birth weight outcomes?

3) How might the implementation of preconception care goals relate to reduced racial and ethnic disparities in birth outcomes? Furthermore, how do the philosophical underpinnings of preconception care fit with the stated desires of women of color and low-income women regarding pregnancy and conception?

Background and Motivations for Preconception Care

The earliest mentions of preconception care in a form that emphasized prevention occur in the medical literature in the early 80s; one document describing preconception care counseling for obstetricians and gynecologists appeared in 1984 (Hollingsworth, Jones, & Resnik, 1984). At the time, preconception care was described as a targeted approach to improve care for women with a previous poor pregnancy outcome. For several decades, the emphasis of preconception care remained targeted in nature, and recommendations largely detailed the counseling topics to include when a woman revealed to her physician her intent to conceive. Advocates promoted the concept of a single preconception counseling visit to answer women's questions and provide an opportunity to alert women to early pregnancy risks. In the early years of this decade, some clinicians and public health practitioners began to call for increased attention to the preconception care period as a means of reducing poor pregnancy outcomes. Responding to the building sentiment that action was needed, the CDC published recommendations in 2006 that dramatically expanded the existing clinical paradigm; they recommended that clinicians and public health officials engage in a systematic effort to assess all women for pregnancy risk, alter behaviors, and provide interventions, regardless of intent to conceive (Johnson et al., 2006).

The driving force behind this paradigm shift lies in the recent stagnation – and in some instances, reversal – of improvements in infant mortality, low birth weight, and preterm delivery rates in the Unites States (Atrash, Johnson, Adams, Cordero, & Howse, 2006). Furthermore, the gap in poor pregnancy outcomes between women of color (especially black women) and their white counterparts has persisted despite increased access to prenatal care. In the decades preceding the CDC report, problems associated with congenital anomalies, low birth weight and short duration of gestation, and pregnancy complications (e.g. pre-eclampsia) climbed into the ranks of the leading causes of infant mortality, supplanting asphyxia, influenza, birth injury, respiratory distress, and sudden infant death syndrome. (This latter group had been mitigated to greater or smaller degree by improvements in medical intervention (including NICU support), public health programs, and infectious disease prevention.)

Increasingly, biomedical and epidemiological research illustrate that low birth weight, congenital anomalies, and preterm birth are less amenable to clinical intervention during pregnancy or delivery than previous causes of infant mortality had been (Lu, Tache, Alexander, Kotelchuck, & Halfon, 2003). Studies have suggested that these "new" top causes of infant mortality may have roots in the physiological state of the mother very early in, or even prior to, pregnancy. In addition, up to 50% of pregnancies in the US may be unintended (unwanted or mistimed) (Finer & Henshaw, 2006); if they elect to continue the pregnancy, women in this category have a higher likelihood of presenting late for prenatal care services (Santelli et al., 2003).

Furthermore, the traditional risk assessment, health promotion, and clinical intervention provided via conventional prenatal care can do little in terms of preventing or correcting low birth weight or preterm delivery (Lu et al., 2003). Typical risk assessments generally identify only half of women who ultimately deliver preterm (Lu et al., 2003). Clinical interventions to delay delivery show mixed effectiveness at best, and the current treatment for intrauterine growth restriction is induction for early delivery, which allows the provision of external sources of nutrition (Behrman & Butler, Institute of Medicine (U.S.)., 2007; Grivell, Dodd, & J. Robinson, 2009; Lu et al., 2003). Prenatal care, by and large, cannot prevent low birth weight or preterm delivery; as a result, increases in access to and utilization of prenatal care by women of color have not resulted in decreases in low birth weight and infant mortality disparities.

Taken together, lack of efficacy of prenatal care, high rates of unintended pregnancy, and research indicating the importance of women's health prior to conception motivated a focus on identifying preconception health care interventions that could reduce rates of congenital anomaly, low birth weight, preterm delivery, and pregnancy complications. Indeed, Atrash et al. write that poor birth outcomes persist because "…we have failed to intervene before pregnancy to detect, manage, modify, and control maternal behaviors, health conditions, and risk factors that contribute to adverse maternal and infant outcomes" (2006, p. S4).

Preconception Care: Definitions and Recommendations

Following the publication of the CDC's preconception care guidelines in 2006, the body of literature focused on this topic began to rapidly expand. Figure 4-1 plots the results of a relatively constrained GoogleScholar literature search to identify English-language articles with "preconception(al)," "interconception(al)," "interpregnancy," or "pre-pregnancy" (with or without the word "care") in the title from January, 1984 through April, 2011. Articles referencing animal models in the title (e.g., "lamb," "sheep," and "rat/mouse"), and articles with references to "tort(s)," "liability," or "sex determination" were excluded.[1] Articles regarding preconception care have increased exponentially over the timeframe in question (a total of 93 articles published prior to 1984 met the search criteria). The increase began several years prior to the publication of the 2006 CDC guidelines and has grown dramatically in the latter half of the decade. Several special or supplemental issues have contributed to this growth: in 2006, *Maternal and Child Health* devoted a special issue to preconception care concerns, and in 2008, two journals (*American Journal of Obstetrics and Gynecology* and *Women's Health Issues*) followed suit.

Articles identified by this search, as well as articles identified by manual search of the bibliographies were reviewed for this commentary; this was not a systematic review, but was intended to provide a representative and wide sample of the literature. Among those articles identified, we concentrated on seminal articles, the three special issues from various journals, heavily cited works, and studies and essays by prominent scholars in the field. As noted above, we paid particular attention within these articles to efficacy of the proposed intervention(s) for reducing low birth weight and racial and ethnic disparities in poor pregnancy outcomes. Overall, the literature takes a positive view of preconception care and its potential. However, given the dramatic

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1) These key words were excluded because of a heavy prevalence in the mid and late 1970s regarding the ethics and legality of sex selection following the advent of assisted reproductive technologies, and the potential for tort liability as a result of "preconception" sex-selective procedures.

rise in attention to preconception care, we undertake a reasoned critique of the ability of preconception care to meet it's stated goals.

Preconception care is, according to the CDC guidelines, "more than a single visit… and less than all well-woman care" (Johnson et al., 2006, p. 3). The paradigm of preconception care is one of behavioral and clinical intervention aimed at identifying and managing risks to positive pregnancy outcomes; the authors also acknowledge the importance of health education and awareness campaigns to the goals of preconception care. The American Academy of Pediatrics (AAP) and American College of Obstetricians and Gynecologists (ACOG) have grouped preconception care recommendations for clinicians and public health practitioners into four general categories: maternal assessment, screening, vaccinations, and counseling (American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2007; Johnson et al., 2006; Atrash et al., 2006). Figure 4-2 details how the specific recommendations in the 2006 CDC report are related to each of these categories and the specific clinic activities involved in each.

Section A of Figure 4-2 lists the 10 recommendations the CDC makes regarding preconception care. The box highlights the recommendations addressed via the guidelines introduced by ACOG/AAP; these recommendations have specific clinical and/or health behavior goals. Although Johnson et al. define preconception care as "a set of interventions that aim to identify and modify biomedical, behavioral*, and social* risks to a woman's health or pregnancy outcome through prevention and management" (2006, p. 3) emphasis added), the 10 recommendations have a clear focus on the biomedical and behavioral. Social conditions such as domestic violence, sexual assault, and exposure to financial instability are briefly mentioned as conditions for which providers should screen, but the guidelines do not expand much beyond screening. In fact, social policy changes are indicated only insofar as they will be needed to permit the development of a health care delivery system built to provide comprehensive preconception care to all women and their families (Johnson et al., 2006).

Sections B and C show the ACOG and AAP guidelines as they relate to the 4 clinical recommendations of the CDC. During each clinical encounter (preventive, chronic disease follow-up, prenatal, etc), women should be assessed and screened for risks to healthy pregnancy (Section B); any identified issues should be addressed via counseling or clinical interventions (such as vaccinations) (Section C). The CDC report identified 14 specific clinical conditions which have, to a greater or lesser extent, a theoretical or empirical evidence base that suggests the potential for preconception care to provide benefits. These conditions include the use of specific known teratogenic medications (anti-acne medications, e.g., isotretinoins, anti-eplieptic medications, and oral anticoagulants, e.g., warfarin); risky health behaviors, including obesity/low physical activity and the use/misuse of alcohol and tobacco; infectious diseases, including HIV, Hepatitis B, and sexually transmitted infections (STIs) (Chlamydia, gonorrhea, syphilis); chronic diseases, including diabetes, hypothyroidism, maternal phenylketonuria; and nutritional and vaccination status, including folate supplementation and rubella vaccination. Of note, the 2008 supplemental issue of *American Journal of Obstetrics and Gynecology* was devoted to the clinical content of preconception care, and further expanded the list of specific diseases and conditions detailed in the original 2006 article. Individual articles in that issue covered each of the main categories of disease (e.g., chronic or infectious disease), as well as special populations and the generalized application of preconception care across the population.

Though an exhaustive review of each disease, condition, or health behavior listed in various articles about preconception care is beyond the scope of this evaluation, we take up the main areas of intervention in turn to explore the relationship between recommendations and the proposed impact on low birth weight and racial disparities. We have defined the main areas as: 1) Disease-focused recommendations (further subdivided into infectious and chronic disease), and 2) Health behavior-focused recommendations.

Disease-focused Recommendations.

By and large, the disease-focused recommendations fall into two broad groups – infectious disease and chronic disease. Within infectious disease, recommendations cover both diseases that should be screened and treated as well as those for which effective vaccinations exist.

Infectious diseases. Among infectious diseases, HIV/AIDS, Hepatitis B, the TORCH diseases (toxoplasmosis, other (e.g., syphilis), rubella, cytomegalovirus, and herpes simplex), and sexually transmitted infections (e.g., Chlamydia and gonorrhea) are featured heavily. TORCH infections are particularly important for poor pregnancy outcomes because these diseases, when contracted during pregnancy, frequently result in severe fetal anomalies and/or fetal loss (Stegmann & Carey, 2002). However, a number of important caveats are worth mentioning. First, TORCH syndrome accounts for 2-3% of congenital anomalies, making it a relatively rare cause of a relatively rare event (Stegmann & Carey, 2002); for instance, rubella may affect fewer than 5 pregnant women per year in the US, nearly all of whom are immigrants from developing countries (Centers for Disease Control and Prevention, 2005). At least one article from the preconception care literature suggests that screening for baseline toxoplasmosis in non-pregnant women might help to identify women who need treatment (Coonrod et al., 2008). Even as Coonrod et al. recommend this, however, they acknowledge that widespread testing is not proven to be effective, and that studies suggest that treating toxoplasmosis in pregnancy may have no effect on congenital infection (2008). Furthermore, it may be expensive and have low specificity, with one review suggesting that 100,000 women would need to be screened to identify 0-40 children with potential congenital toxoplasmosis exposure (Eskild, Oxman, Magnus, Bjørndal, & Bakketeig, 1996; Peyron, Wallon, Liou, & Garner, 2000; Wallon, Liou, Garner, & Peyron, 1999).

In addition to the relative rarity of the most serious TORCH infections, across the board, there is little that can be done to prevent transmission or improve birth outcomes once a woman has been exposed. In the preconception period, vaccination against rubella is important, but over 90% of the US population is already immune, leading the CDC to declare rubella no longer endemic in the US (Centers for Disease Control and Prevention, 2005). In general, preconception counseling regarding exposure to TORCH infections is likely to have, at best, a small effect on low birth weight and preterm delivery. Furthermore, though racial disparities in exposure to cytomegalovirus and herpes simplex-2 exist (Bristow, O'Keefe, Shafir, & Sorvillo, 2011; Centers for Disease Control and Prevention, 2010), given the rarity (e.g., a review of death data suggest approximately 46 deaths per year occur from congenital cytomegalovirus (Bristow et al., 2011)) and ineffectiveness of treatment, it is unlikely that racial disparities in poor pregnancy outcomes would be affected as a result of preconception attention to the infectious agents that produce TORCH syndrome. Furthermore, differences in infant mortality rates between black and white mothers as a result of these types of viral and bacterial illnesses are negligible. In 2001, 0.5% of infant mortality among whites was a result of viral diseases (including HIV) and unspecified bacterial or parasitic diseases; for blacks, the figure was 0.7% (National Center for Health Statistics, 2001).

Hepatitis B is similarly problematic as far as an expected reduction in poor pregnancy outcomes; though greater than 90% of infants who contract Hepatitis B via vertical transmission will ultimately have chronic liver disease, the number of births to Hepatitis B-infected mothers in the US is low (~6,000 births out of over 4 million pregnancies per year), not all infants develop Hepatitis B, and the near-universal inoculation of infants at birth against Hepatitis B regardless of maternal seropositivity has greatly decreased the risk of vertical transmission, including from breastmilk (Chang, 2007). Furthermore, maternal hepatitis B infection does not confer any additional maternal morbidity and mortality or infant morbidity and mortality risks, except in the case of acute hepatitis with reductions in liver function; this is also true of hepatitis C (Chang, 2007; Valladares, Chacaltana, & Sjogren, 2010). While identification of hepatitis infection prior to pregnancy may help to improve women's treatment and reduce risk of exposure to other family members, it does not seem likely to improve infant outcomes with regard to birth weight, prematurity, or infant mortality.

Two overarching themes characterize the literature promoting infectious disease identification during preconception care: 1) the impact of the most commonly discussed infectious diseases on population-wide incidence of low birth weight, infant mortality, or prematurity is questionable; and 2) there is a conspicuous lack of treatments or interventions that are *uniquely effective in the preconception period* that will reduce what impact these diseases might have on pregnancy. From a racial disparities perspective, many of these diseases (for instance, both HIV and hepatitis B) affect African American women to a greater extent than white women. Overall, however, there is considerable lack of evidence that reducing the impact of these diseases on pregnancy will significantly reduce racial and ethnic disparities in pregnancy. Education can ostensibly help to reduce exposure (e.g., reducing risky sexual behaviors may reduce exposure to hepatitis B or HIV), but it is unclear how well clinical counseling interventions improve safe sexual practice.

Chronic diseases. Of the chronic diseases that have received attention in the literature, diabetes is by far the most prominent. The relationship between congenital anomalies and poor glycemic control (in pregnancy complicated by any type of diabetes) is well documented (Correa et al., 2008; Macintosh et al., 2006). Furthermore, extremely elevated HbA1c is related to intrauterine growth restriction due to lack of oxygen and nutrient delivery to the fetus because of utero-placental dysfunction (moderately elevated HbA1c, on the other hand, is related to high birth weight, the more common consequence of diabetes during pregnancy) (Rackham, Paize, & Weindling, 2009). Placental dysfunction as a result of diabetes in pregnancy can also cause stillbirth, especially for women with Type 2 (mature onset or insulin resistant) diabetes mellitus (DM-2); one study reports a 7-fold increase in late fetal death (>28wks gestation) in women with DM-2 compared with women with gestational or Type 1 diabetes (DM-1) (Cundy et al., 2000). Improved periconceptional glycemic control may decrease the number of congenital anomalies as well as late fetal losses and preterm deliveries (Wahabi, Alzeidan, Bawazeer, Alansari, & Esmaeil, 2010). However, though there is strong evidence for improved pregnancy outcomes as a result of better glycemic control during pregnancy, the differential impact of achieving glycemic control prior to pregnancy versus early or even mid-way through pregnancy has not been established; Cochrane Reviews has recently declined to make a recommendation for or against preconception diabetes control on the basis of insufficient evidence (Tieu, Middleton, & Crowther, 2010)

With regard to disparities, the picture is even less clear. In some studies of gestational diabetes, African American women have lower rates of gestational diabetes than Hispanic women; in spite of this, African American women have higher complications of pregnancy, including stillbirth, than Hispanic women (Hunsberger, K. D. Rosenberg, & Donatelle, 2010; Brown, Chireau, Jallah, & Howard, 2007). In fact, there is a chance that while attention to gestational and pregestational diabetes (and obesity/physical activity as a precipitating factor) may improve pregnancy outcomes overall, it may exacerbate disparities for African American women, whose pregnancy outcomes may not be as responsive as other racial groups' to diabetes treatment; in at least one study, chronic diabetes was not closely associated with low birth weight for African American women, but was related to low birth weight for white, Hispanic, and Asian women (T. J. Rosenberg, Garbers, Lipkind, & Chiasson, 2005).

Health Behavior-focused Recommendations

Five healthy lifestyle/health behavior factors related to birth outcomes feature heavily in the preconception care literature: obesity, alcohol use, tobacco use, unplanned pregnancy, and folate supplementation. Obesity is associated with infertility, diabetes, hypertension, and other cardiovascular diseases, as well as with preterm delivery (especially induced preterm delivery), stillbirth, macrosomia and congenital malformations (Ramsay, Greer, & Sattar, 2006; Arendas, Qiu, & Gruslin, 2008; Nohr et al., 2005; Rasmussen, Chu, Kim, Schmid, & Lau, 2008; H. E. Robinson, O'Connell, Joseph, & McLeod, 2005). It is not clear, however, whether these associations with pregnancy outcome stem strictly from the physiological changes of obesity or from another clinical or subclinical disease process associated with obesity. Obesity complicates a higher number of pregnancies for black women, and it may differentially impact rates of stillbirth among extremely obese black women when compared to extremely obese whites (Salihu et al., 2007). Unfortunately, a systematic review of dietary interventions to reduce obesity and weight gain during pregnancy showed no differences in birth outcomes between intervention and control groups (Dodd, Grivell, Crowther, & J. Robinson, 2010; Siega-Riz & Laraia, 2006).

Unintended pregnancy is sometimes found to be associated with higher risk of poor pregnancy outcome; however, significant issues with the meaning of intent, recall bias of intendedness, and the confounding chaotic life factors that often co-exist with unintended pregnancy make results difficult to interpret (Barrett & Wellings, 2002; Dott, Rasmussen, C. J.

Hogue, & Reefhuis, with National Birth Defects Prevention Study, 2009; Kost, Landry, & Darroch, 1998a; Santelli et al., 2003). Other studies that control for social and demographic factors have found no differences in outcomes and no difference in prenatal care-related health behaviors (other than late recognition of pregnancy/late entry into prenatal care and tobacco cessation) among women with an unintended pregnancy (Kost, Landry, & Darroch, 1998a; 1998b). Several large studies that suggest a relationship between intendedness and periconceptional behavior changes do not report on actual pregnancy outcomes.

Altering health behaviors in the preconception period may produce improvements over addressing these issues in the prenatal period. For instance, quitting tobacco products is often associated with relapse, even during pregnancy; helping women to achieve tobacco-free lifestyles prior to pregnancy would reduce fetal exposure to tobacco and associated chemicals (Lumley et al., 2009). However, behavioral change interventions, most especially those provided in brief clinical encounters, have mixed success at best (Korenbrot & Moss, 2000). Especially for addictive substances, relapse is common, and interventions that work require intensive time and social support (and beg the question of the relative importance of the intervention vs. the social support). Patients report that advice from a doctor is an important incentive for changing risky health behaviors in pregnancy (Dott, Rasmussen, C. J. Hogue, & Reefhuis, 2009), but qualitative interviews with women enrolled in a multi-faceted clinical trial evaluating pregnancy outcomes and preconception care efforts reveal that advice alone may be insufficient to produce change. Women reported that their receptivity to many of the recommendations of preconception care, would depend strongly on whether they were contemplating a pregnancy – in other words, an internal motivational factor is necessary (Mazza & Chapman, 2010). Furthermore, with regard to disparities, multiple studies have found that lifestyles and health behaviors cannot explain racial and ethnic disparities in low birth weight, prematurity, and infant mortality (Ehrenthal, Jurkovitz, Hoffman, Kroelinger, & Weintraub, 2007). Preconception care's significant dependence on the clinical encounter and health behavior change to realize reductions in pregnancy outcomes is a major weakness in its promise for ameliorating racial and ethnic disparities in health.

Preconception care evaluations

Despite the volume of articles recommending guidelines and approaches for preconception care, few evaluations of preconception care interventions exist; most focus specifically on diabetic care or folate supplementation. The handful of trials of more broadly-focused interventions show mixed or no effects. For instance, one randomized, controlled trial in Australia used an interconception care paradigm to provide counseling, referral for health risks, rubella vaccination, discussion of social, health and lifestyle problems, and reminder cards to women in an inner-city area. They evaluated birth weight outcomes in subsequent pregnancies, and found a higher incidence of poor outcomes and lower birth weights in the intervention group. The study was designed for one-tailed inference in favor of the intervention, so they did not provide statistical details on this outcome (Lumley & Donohue, 2006). Another small pilot trial identified African American mothers who recently delivered a very low birth weight infant for enrollment into a program of clinical preconception care and social support (life skills coaching). This trial found that the preconception care intervention arm lengthened the interpregnancy interval and reduced the incidence of subsequent low birth weights (Dunlop et al., 2007). However, there is no way to know whether the clinical interventions such as those recommended by preconception care or the social support efforts, or a combination of these, helped to improve outcomes in this group of women.

Other trials have measured intermediate outcomes, especially those might have positive impacts on behavior change. For instance, one study found that women who received preconception counseling had improved internal locus of control, which they speculated could empower women to make lifestyle changes prior to pregnancy (F. Bastani, Hashemi, N. Bastani, & Haghani, 2010). Another study found that preconception counseling and classes in negotiation skills could reduce the number first pregnancies among teenagers in a federal Healthy Start program, but did not test birth outcomes (Salihu et al., 2011). Again, this finding raises the issue of cross-classified interventions; this intervention included classes on interpersonal negotiation skills, which are most often not included in the general clinical preconception care recommendations. There is a possibility that these negotiation skills proved more important in the delay of first pregnancy among teens than the preconception care counseling. This is not to suggest that additional skill sets and interventions should not be attempted, especially for high-risk populations; rather, it is an observation of the potential shortcomings of a solely clinically-focused endeavor such as preconception care. Indeed, research into low-income adolescents' preferences for birth control and pregnancy prevention suggest that they need and desire skills in negotiating condom use with partners (Gilliam, Davis, Neustadt, & Levey, 2009).

Underlying Philosophies of Preconception Care: Individuals, Risk, and Fragmentation

Individual Focus

On the face of it, the preconception care paradigm has the laudable goal of improving women's health before they become pregnant, which will (it is argued) subsequently reduce disparities. However, disease-based public health and clinical approaches like preconception care focus on individual women and the symptoms they might (or might not) have; in doing so, they may address specific problems with a given individual's health or pregnancy, but such approaches are unlikely to alleviate health disparities on a broad scale because they do not deal with the factors that place women at risk of risks (Link & Phelan, 1995; Marmot, Bobak, & Davey Smith, 1995; Rose, 1985). This may be particularly true for racial disparities in prematurity and low birth weight; when nearly one-half of all preterm births have no discernible precipitating medical condition, earlier health care is not likely to prevent the early birth (Lu et al., 2003; Mercer, 1996). Unfortunately, a continued focus on individualized health care access and health behavior does not address the "population shift" that Rose describes as necessary to move an entire population away from health risk and into health resilience (1985). Because they do not address the fundamental structures that create risk, and depend upon institutions and behaviors predicated on those structures, individually-based medical interventions like preconception health care can only take us so far in improving the health of populations (Lantz, Lichtenstein, & Pollack, 2007; Tarlov, 1999).

As an individualized intervention strategy, the preconception health paradigm depends heavily upon the accessibility and quality of health care providers. Wide disparities in access to and quality of available services exist, especially in underserved urban areas (Institute of Medicine, 2003). Simply expanding access to health insurance, as proposed by preconception care advocates, is unlikely to mitigate the problems of access to care (Institute of Medicine, 2003). Poor, racially segregated neighborhoods often suffer a lack of access to primary care and tertiary hospitals, which has been linked to poorer birth outcomes (Grady & Ramírez, 2008).

Proponents' cursory treatment of social risk factors for poor pregnancy outcomes suggests an implicit belief that either: 1) preconception care is inadequate to address the social risks factors for poor pregnancy outcome; or, 2) that identified social risk factors for poor pregnancy outcome serve largely as indicators or correlates of disorganized provision of health care interventions and poor health behaviors rather than as risks in their own right. If the former, preconception care might be seen as an opportunity to address proximal causes of poor pregnancy outcomes in the absence of action on more distal outcomes. We agree that individual health and behavior should not be cast aside in favor of concentrating only on social determinants (Korenbrot & Moss, 2000); however, we find that the majority of the literature in preconception care not only fails to address social determinants, but also fails to acknowledge the limitations that social determinants might place on achieving the disparities reduction goals of preconception care.

The underlying assumptions driving preconception care recommendations for a reproductive life plan are a particularly salient example of blindness to cultural, social, and structural barriers to preconception care recommendations. The very idea of a reproductive life *plan* is antithetical to the often-chaotic lives of lower-income women, for whom 'planned pregnancy' means something different as compared to the privileged perspective of middle-class (predominantly white) women (Edin & Kefalas, 2005; Barrett & Wellings, 2002; Canady, Tiedje, & Lauber, 2008; Lifflander, Gaydos, & C. J. R. Hogue, 2006; McCormick et al., 1987). Younger, lower income

African American women in a focus group study regarding pregnancy planning and preconception care reported that it was sometimes easier to deal with an unplanned pregnancy that to deal with preventing pregnancy (Canady et al., 2008).

Though the preconception care guidelines state that the reproductive life plan is used to help women articulate when and if they would like to become mothers (i.e., the plan should reflect the woman's desires), the unspoken assumptions that pierce the discussion of such matters in the preconception care discourse are that any woman who articulates a "more risky" childbearing plan, or the lack of one altogether, should be encouraged to start birth control until the appropriate level of preconception health can be achieved (Moos et al., 2008). In other words, the discourse (unwittingly, perhaps) reflects the privileging of white middle class and upper-middle class norms for planned childbearing: childbearing should be meticulously prevented until sometime after the teenage years, and until the woman has sufficient material and social resources between herself and her partner to successfully care for a child.

At the very least, this may be how African American women perceive the conversation about "planned pregnancy" (Canady et al., 2008; Lifflander et al., 2006). Only two preconception care articles (of 175 we reviewed) suggested that the social context of African American women's lives might play a part in their understanding of "planned pregnancy" and receptiveness to preconception care goals; Canady et al., after interviewing African American women about their opinions of preconception care and the meaning of planned pregnancy, assert that the context of African American women's lives suggests that individual medical encounters may not be sufficient to achieve the goals of preconception care, and they recommend improved public health education on this point (2008).

The social context is further complicated by a history of controlling black women's reproduction by force, coercion, and social stigma that stems from the early days of slavery and slave breeding and runs right through to modern day forced sterilization scandals (D. E. Roberts, 1999; Schoen, 2005). Skepticism regarding reproductive control understandably pervades African American communities (D. E. Roberts, 1999; 2000). Simply admonishing young women of color to exercise reproductive control does not take the context of women's lives into account, or acknowledge that for African American women, the idea of the career woman planning her pregnancy may seem Eurocentric (Canady et al., 2008).

Edin and Kefalas find that low income women of color, while they may not "plan" their pregnancies in the same way that women with more means might, often make a conscious decision to raise a child as an avenue for creating worth and meaning in their lives (2005). In fact, the women Edin and Kefalas interviewed suggested that strictly controlling reproduction to wait for more means (i.e., "Murphey Brown childbearing") was selfish; alternatively, too much active planning might be seen as acting against the will of fate or some higher power. These beliefs and others lead to a large role for ambivalence: women may not actively pursue the pregnancy, but they may also knowingly act in ways that do nothing to prevent it. This kind of ambivalence about pregnancy does not fit on the "linear spectrum of planned pregnancy" (Canady et al., 2008, p. 94) that is too often presupposed by preconception care literature. With opportunities for employment, education, and self-validation constrained, low income young women may choose motherhood, even in poor economic circumstances, as an avenue for reinforcing their self-worth and their identities (Gibson-Davis, 2009; Edin & Kefalas, 2005; Canady et al., 2008). Rightly or wrongly, these cultural and structural influences increase rates of unplanned childbearing by young low-income women, and these influences are unlikely to be mitigated by a four-question reproductive life plan such as those advanced in the literature (Klerman, 2006; Moos et al., 2008; Sanders, 2009).

These findings underscore that, in addition to community and cultural beliefs, the broader structural determinants of health (education, employment opportunities, men's incarceration) play an important role in "unplanned" childbearing by low income women. This holds true for other types of risky childbearing, from (uncontrolled) co-morbid chronic disease to maintenance of healthy behaviors (e.g., nutritious food, exercise). One study finds that 75% of US women of childbearing age are exposed to structural, institutional, and social barriers to good health for themselves and their family, and that the risks are particularly high in low resource settings (S. H. Ebrahim, Anderson, Correa-de-Araujo, Posner, & Atrash, 2009).

Research is just beginning to explore how preconception care might operate in practice in low-resource settings. For instance, one recent study finds that the uptake of preconception care is independently related to maternal deprivation (Tripathi, Rankin, Aarvold, Chandler, & Bell, 2010); this suggests that without attention to women's circumstances, preconception care might struggle to realize the objectives it intends to achieve. Importantly, the structural and social determinants of health do not apply strictly to low-income women. African American women at every level of socioeconomic status experience higher rates of low birth weight and infant mortality than their white counterparts, suggesting that individual income and education alone cannot explain the gap and that further attention should be paid to structural factors affecting African American women (Collins & David, 2009; Krieger, 1991; 2003). As Osypuk and Acevdo-Garcia have pointed out, eliminating racial disparities in birth outcomes requires us to identify those exposures that *differentially* impact or *uniquely* confront African American mothers (2008). Unfortunately, the preconception care literature largely ignores the impact of social determinants of health such as employment, education, financial stability, and residential quality; in fact, one article by a prominent author in the field claims:

> Burden of disease, access to preventive health services, and the degree to which individuals can process and act on recommendations that will impact a not-yet-conceived-child may prove to be the underlying determinants of disparities. (Moos & Bennett, 2011, p. 89)

In addition, the preconception care literature makes an implicit assumption about the nature of population-wide intervention. This is most clearly articulated by the preconception care mantra, "Every woman, every time." This sentiment, coupled with discourse in the reviewed papers, reflects an underlying philosophy that a rising tide lifts all boats – that is, if we can extend universal primary prevention of poor pregnancy outcomes to individuals population wide, we will witness a dramatic improvement in pregnancy outcomes, including a reduction in health disparities in poor pregnancy outcome. Unfortunately, unless primary prevention begins to include the social determinants of poor pregnancy outcome – unless we go "upstream" enough to address the social context facing pregnant women of color and lower income women, we will be relegated to attempting to screen for and treat the symptoms of their exposure to unequal opportunities and circumstances (Link & Phelan, 1995). Until we understand and address the dearth of opportunity and the spatialized/racialized nature of opportunity that faces women in the US, especially women of color and low income women, we have little hope of addressing the factors that lead to disparities in birth outcomes.

Risk Focus

Ultimately, the premise of preconception care is based on a risk-focused paradigm that seeks to identify and treat risks to pregnancy before they cause morbidity or mortality. This is a fractured approach that opens the door to victim blaming and hyperinflation of the type and severity of risk. For myriad reasons, the risk paradigm and the fear it can create have been invoked repeatedly in public communication about women's reproductive health issues. For instance, Armstrong's detailed account of fetal alcohol syndrome (FAS), and the subsequent medicalization and hyperinflation of the risk associated with alcohol consumption during pregnancy, provides a vivid account of the ways in which a tightly constrained diagnosis with moral underpinnings can be invoked to create a fear- and shame- campaign to control women's reproduction (Armstrong, 1998). Though research over the last several years has all but concluded that low to moderate alcohol consumption during pregnancy has no association with poor pregnancy outcomes, behavioral health outcomes, or any number of other outcomes (Y. Kelly et al., 2009; Mullally, Cleary, Barry, Fahey, & Murphy, 2011; M. Robinson et al., 2010), US public health practitioners (including the preconception care literature) have not acknowledged this evidence. Preconception care literature repeatedly states that no level of alcohol consumption in pregnancy is safe, and that women of childbearing age should be advised to reduce or cease alcohol intake in the periconceptional period even if pregnancy is not desired (American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2007; Floyd, S. Ebrahim, Tsai, O'Connor, & R. Sokol, 2006; Floyd et al., 2008; Jack, Culpepper, Babcock, Kogan, & Weismiller, 1998). In contrast, the Royal College and other medical groups in the United Kingdom state that although abstinence is the safest policy, low amounts of alcohol are unlikely to be harmful after the first trimester; furthermore, at least one author argues that we must "respect women's autonomy" by helping them make informed decisions about risk rather than overstating it (O'Brien, 2007).

Yet another example is a recent ad campaign to encourage breast-feeding that equated not breast-feeding a newborn with bull-riding while pregnant (Wolf, 2007). Though we heartily agree that breastfeeding should be encouraged, and that significant structural and policy barriers prevent successful breastfeeding among mothers, the risk of not breastfeeding in developed countries is hyperinflated, and in Wolf's example, the campaign was designed to induce guilt and fear. For mothers for whom medical or social-structural constraints (such as HIV status), or for mothers whose lives intersect directly with the policies (like free formula in hospitals or insufficient time/places at work to pump breastmilk) that discourage breastfeeding, campaigns like these succeed only in creating stigma rather than improving breastfeeding rates by addressing the structural barriers to breastfeeding success.

The same may be said of preconception care, which looks upon the entirety of a woman's reproductive life as a high-risk period that must be monitored and controlled (Atrash et al., 2006; Moos et al., 2008; Moos, 2006). If a woman fails to monitor and control (or submit to being monitored and controlled) through this approach, where will the blame for her poor pregnancy outcomes lie?

We believe it is this risk-based approach that has encouraged criticism of preconception care as pro-natalist (Briceno, 2008; Waggoner, 2010). Proponents of preconception care claim that it is a woman-centered approach, which, if that argument is based solely on the types of interventions promoted by preconception care guidelines, is debatably true (Atrash et al., 2008). As we have noted, many proposed interventions have little direct impact on pregnancy outcomes (e.g. hepatitis B and hepatitis C), but may have benefits for women. In addition, many (if not most) of the recommendations for preconception care do not differ from preventive medicine guidelines *for women in general* (e.g., exercise, chronic disease control, etc.) and in fact, we believe they may be more likely to benefit individual women's health than to improve pregnancy outcomes. But we are wary of the isolation of yet another aspect of reproductive health from the overarching context of women's lives and well-being (for the ostensible purpose of protecting fetuses), and suspect that this is what generates concerns about pro-natalism. For instance, abortion care has been marginalized from women's health care for decades, and has suffered this isolation mightily in political, financial, and social terms (Joffe, 2010). The preconception care paradigm is ultimately one of isolation – isolating the reproductive period from the social, structural, relationship, and other health contexts of women's lives for the purpose of pointing out pregnancy risks.

In the face of potential benefit to basic women's health/primary care, some have questioned what harm a preconception care approach might do. We suggest that harms of a preconception care approach exist at the individual level, in the isolation of pregnancy from other health care, and in the medicalization of a healthy period of life. Treating health individuals as though they have a disease or potential disease opens the door to numerous health care disadvantages. For instance, increased health screenings using non-specific tests increases the number of false positives (e.g., screening for toxoplasmosis) which must be followed up, causing increased stress, costs to individuals, and costs to society.

Furthermore, shifting blame for poor pregnancy outcomes to individual women and their use (or not) of preconception care is harmful in the sense that society and political rhetoric focuses on the individual women's shortcomings rather than the structural shortcomings which contribute to and maintain the poor pregnancy outcome; this is especially harmful when little evidence exists to suggest that if women undertook the recommendations included in preconception care we would see a reduction in rates of preterm delivery or small for gestational age births. Without clinical answers to the reasons for these outcomes, we do women a great clinical and societal disservice to place the burden of change on their shoulders.

There is also harm at the social and political level which is perhaps the greater of the two. Limited policy dollars exist to address poor health outcomes such as low birth weight. When a policy is proposed to achieve the objective of reducing low birth weight disparities, those policies should be scrutinized for their ability to actually achieve their stated objectives – the harm here lies in the expenditure of time, effort, and limited financial resources for a program that is ultimately unlikely to deliver on its stated goals.

Rather than focusing strictly on the pregnancy risks associated with women's actions in the preconception period, we argue that the re-integration of women's reproductive health into women's health generally is a better approach. Rather than predicating receipt of health care or the identification of risk factors on whether a woman can bear children, we argue that a more universal approach which re-contextualizes women's health within their lived experience will provide a better reduction in poor pregnancy outcomes. This argument differs from the preconception care argument that preconception care should be part of "every woman's [clinical visit] every time;" rather, we are arguing that "preconception care" bears a striking resemblance to what should be, simply, high quality women's health care. Couching it in terms of future reproduction is not only isolating and potentially stigmatizing, but may also (inadvertently) lead to reduced quality of care for lesbians, young women, old women, and infertile women for whom this paradigm is not applicable.

To be absolutely clear, we are not arguing against comprehensive women's health care services, or even heightened attention to women's pregnancy desires within the clinical encounter. Rather, given our analysis of the recommendations as described in the literature, we question the ability of preconception care as currently promoted to actually produce reductions in important pregnancy outcomes such as low birth weight and prematurity, and furthermore, to produce meaningful reductions in racial disparities in poor pregnancy outcomes. In a political and financial atmosphere of evidence-based medicine, these interventions will be judged against the goals they set out to accomplish. It seems unlikely that, judged against the goal of reducing disparities in low birth weight, preconception care would fare well.

Over the course of the last few years, the preconception care literature has appeared to become a bit more conservative on this point, which we welcome. Some proponents have shifted focus to reduction in congenital anomalies, for instance, which is currently better supported by the evidence (e.g., via glycemic control and folate supplementation). In addition, it is reasonable to suspect benefits from and even encourage primary care providers to consider a woman's pregnancy plans and provide counseling in targeted situations (e.g., chronic diabetes, after a poor pregnancy outcome). For clinical programs, targeted intervention is likely to have a greater impact than broad population-based programs (Biermann, Dunlop, Brady, Dubin, & A. Brann, 2006). However, the underlying philosophy of preconception care – that behavioral change and specific attention to reproductive health and potential child-bearing will alter the fundamental causes of disparities in birth outcomes – remains problematic, and poses significant challenges to the mitigation of disparities.

In the face of the evidence, we hypothesize that a population-wide effort to reach all childbearing women to alter their lifestyles and change their preventive screening status will fall flat insofar as pregnancy outcomes are concerned because behavioral change cannot happen in a vacuum, and because isolating "preconception care" as a different element of women's health care decontextualizes women's reproductive health in ways that will diminish the effectiveness of any health promotion campaign. Furthermore, the scarcity of resources for health policy and reduction of health disparities makes it imperative that we do not rush headlong into the paradigm of preconception care without a better understanding of its pitfalls and the shortcomings in its promised outcomes. Focusing on these clinical and individual efforts as a main avenue for improving birth outcomes ignores the fact that birth outcomes and behavior change both depend upon the social context in which they occur (Korenbrot & Moss, 2000). We need to focus our resources on improving and breaking down structural barriers – such as employment, education, racial segregation, and their psychosocial consequences – that create and maintain the health risks that ultimately manifest in poor pregnancy outcomes. Without attention to these structural determinants of pregnancy outcomes, we will find ourselves struggling with an ever-growing list of individual diseases and risks to pregnancy outcomes; the disease "cast of characters" will change, but poor pregnancy outcomes and racial inequities will remain. We must reintegrate women's health into a comprehensive effort that focuses on fostering resiliency across the life-course by reducing structural barriers and offering women the opportunities they need to make choices that empower and reaffirm them as it relates to their health, their lives, and their families.

Figures

Figure 4-1. Growth in Articles with Preconception Care in Title, 1984-2010

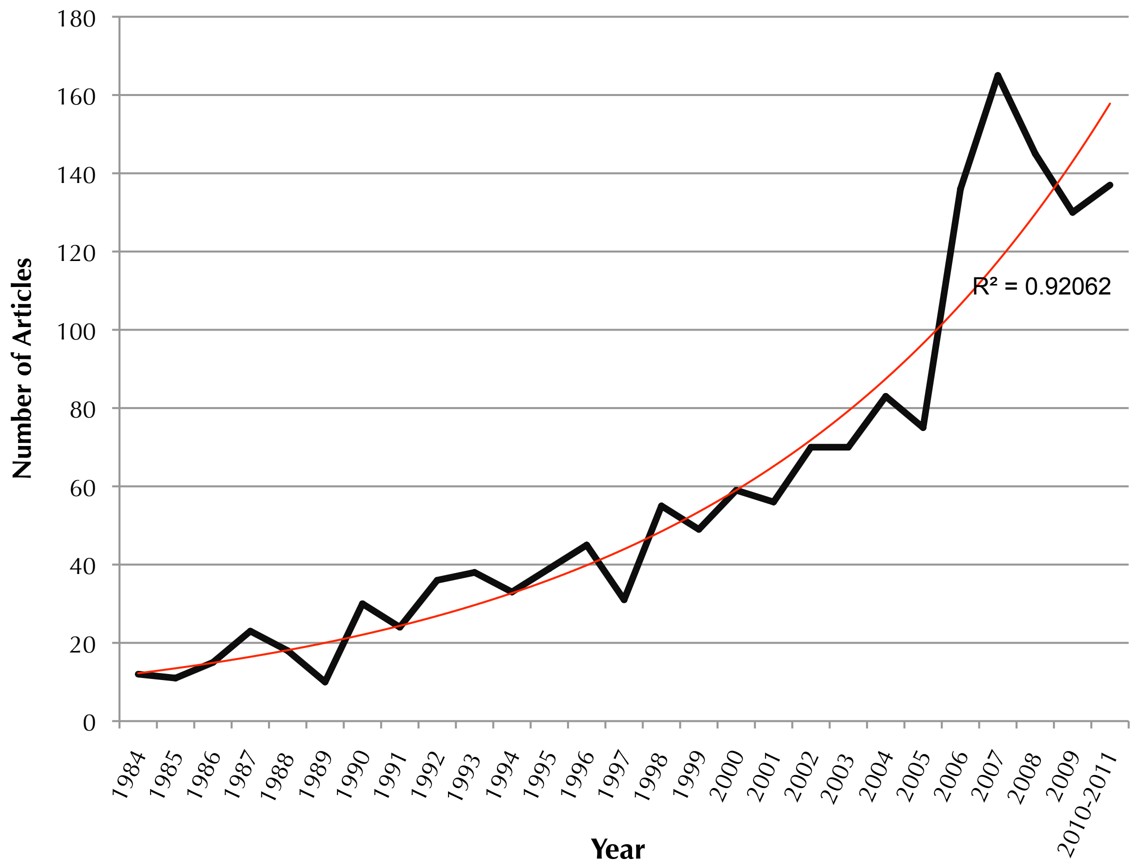
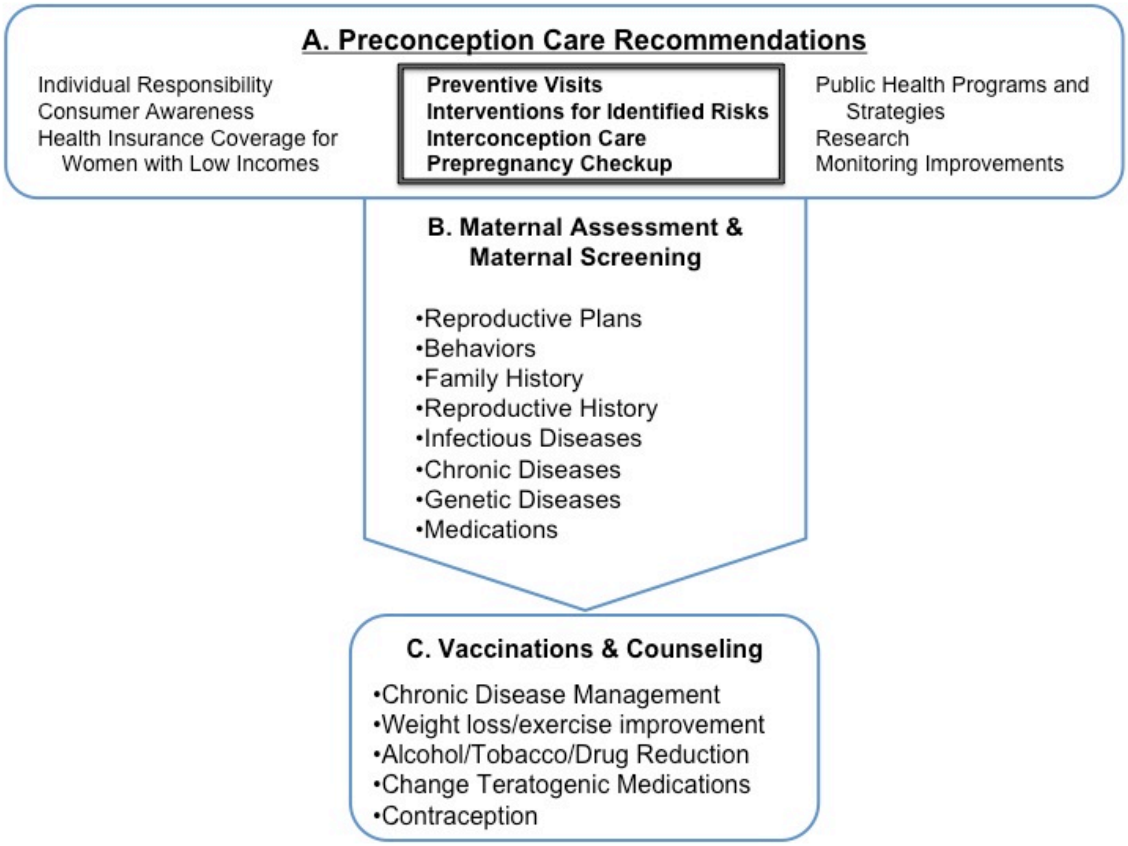


Figure 4-2. Centers for Disease Control and Prevention's 2006 Preconception Care Recommendations and Related ACOG/AAP Clinical Care Guidelines



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CHAPTER 5:

RACIAL INEQUITIES IN LOW BIRTH WEIGHT OUTCOMES:

WHERE TO FROM HERE?

> *From Marx, to Durkheim, to Weber in sociology, and from Virchow to Snow to the Roemers outside of sociology, the understanding that stratification plays itself out, in part, in morbidity and mortality statistics represented a principal theme of theory, empirical investigation and the design of interventions (Pescosolido and Kronenfeld 1995).*

The overarching goal of this dissertation was to investigate how one element of social stratification – racial residential segregation – could contribute to inequities in low birth weight outcomes between women of color and white women. Following the path laid out by sociologists and epidemiologists from Durkheim to Link and Phelan, I have endeavored to: 1) to establish a clearer understanding of the racial segregation experiences of multiple racial and ethnic groups, and the relationship between residential segregation and low birth weight for these groups; 2) to delve more deeply into social capital theories of association between neighborhoods and birth outcomes; and 3) to evaluate a widely-touted intervention to reduce low birth weight and infant mortality against clinical, feminist, and social epidemiological perspectives. This work begins to add nuance to our understanding of racial segregation and birth outcomes, in hopes that future interventions and policy prescriptions to reduce low birth weight inequities may meet with greater success.

Multi-group Racial Segregation and Birth Outcomes

The findings from Chapter 2 corroborate others researchers' findings of an entrenched association between low birth weight and racial residential segregation for African American mothers. A particular strength of the work we have conducted is the use of local residential isolation, which better describes the neighborhood in which a mother lives, to evaluate the relationship between segregation and low birth weight. While metropolitan-level studies have documented this association well, these findings bolster theoretical descriptions that implicate socially and physically stressful circumstances in the relationship between segregation and low birth weight; in other words, others have suggested that it is mothers' experience of living in a segregated neighborhood that matters, yet we cannot be certain of that relationship when segregation is measured at the metropolitan level. Because we find a detrimental association between locally-measured segregation and low birth weight, the concept of a direct impact of living in these communities is bolstered.

Furthermore, these associations hold within racial strata – that is, black women living in neighborhoods that are racially isolated from whites have higher odds of delivering a low birth weight baby than black women living in neighborhoods that are not isolated from whites. This provides yet another piece of evidence that racially segregated neighborhoods represent a detrimental exposure which harms pregnancy outcomes for black women. These associations persist despite controlling for neighborhood poverty status, neighborhood opportunity structures for women, and structural residential instability.

However, in this study we find no significant impact of isolation from other racial or ethnic groups (Hispanics or Asian/Pacific Islanders); this fits with a view of segregation as a mechanism of stratification, or a fundamental force shaping the distribution of power and resources. It is the isolation from whites, the group for whom power and resources are most available, which is detrimental.

We also corroborated earlier findings that suggest that, for black women, the association between racial isolation and low birth weight operates via higher likelihood of small for gestational age birth (Debbink & Bader, 2011). Though the drivers of intrauterine growth restriction are many, it is plausible that chronic stress from living in a racially segregated neighborhood may contribute to the development of placental vascular pathology which can limit the oxygen and nutrients that reach the fetus; though not specifically related to pregnancy, other studies have found that living in a residentially segregated area increases African Americans' risk of hypertension, indicating a potential impact on vascular function (Thorpe Jr., Brandon, & LaVeist, 2008). Alternatively, racially segregated neighborhoods may both create and sustain health behaviors that contribute to intrauterine growth restriction, such as tobacco exposure. A combination of increased corporate pressure on these neighborhoods (in the form of advertising and availability), maladaptive stress coping mechanisms (e.g., substance use), and social influence/exposure may drive higher rates of smoking among individuals who live in segregated neighborhoods (Barbeau, Wolin, Naumova, & Balbach, 2005; Bell, Zimmerman, Mayer, Almgren, & Huebner, 2007; Hackbarth, Silvestri, & Cosper, 1995; LaVeist et al., 2008).

We were somewhat surprised to find little difference between our study in Los Angeles and findings regarding segregation and health from studies of the Rust Belt/Midwest and east coast areas. Because multiple racial and ethnic groups share the residential spaces in Los Angeles County, it is plausible that segregation has a different meaning and represents a different kind of exposure for various racial and ethnic groups. We find, however, that though the proportion of blacks has declined in Los Angeles, and both the proportion and social/political impact of other groups has increased, there are striking similarities in the association of residential segregation and low birth weight among African American women in Los Angeles County and in the more traditionally-segregated areas of the US. As Charles describes it, though the make up of the city may be different, the realities of segregation remain (Charles, 2009); for pregnant black women, this includes exposure to segregated neighborhoods and the attendant increased risk of low birth weight outcomes.

Somewhat counter-intuitively, we find that exposure to segregated neighborhoods may be similarly detrimental for Hispanic women. Though Hispanic women's absolute rates of low birth weight birth are low, the study we conducted suggests that within the population of Hispanic women, those living in racially isolated neighborhoods have higher odds of having a low birth weight baby. Given the combination of scholarship on the "Hispanic paradox" and findings that

Hispanic segregation might have a close relationship with economic means, we expected that Hispanic-White isolation might have either a neutral or a protective effect for Hispanic women. Research on the "Hispanic paradox" finds that recently-immigrated women have better outcomes than either their US born counterparts or US white women, despite generally lower socioeconomic status; in addition, increasing acculturation to US norms is associated with poorer pregnancy outcomes. Taken together, we surmised that Hispanic women living in areas that were isolated from whites might have less acculturation to US norms and/or higher numbers of foreign-born women, both of which would ostensibly improve pregnancy outcomes. To the contrary, our research suggests that Hispanic women's experience of racially isolated neighborhoods in Los Angeles County more closely mirrors that of blacks – racial isolation from whites is associated with higher odds of low birth weight, independent of income and other neighborhood disadvantage measures.

Of note, the association between segregation and small for gestational age or appropriate for gestational age early births differs between Hispanics and blacks. Where black women living in racially segregated neighborhoods have a clear higher likelihood of small for gestational age birth, Hispanic women living in isolated neighborhoods have a higher likelihood of both appropriate for gestational age and small for gestational age low birth weight infants. This may suggest heterogeneity of physiological response to racial isolation as a stressor, either as a result of heterogeneity of country of origin (i.e., there is some danger in treating all Hispanic women *en bloc*, as their backgrounds, demographic experiences, etc., differ substantially, which could translate into different pathophysiology given the same health insult), or as a result of heterogeneity in foreign-born vs US-born responses. Though our findings from the cross-level models were not definitive, there is a suggestion that associations between neighborhood context, including racial isolation, may differ for foreign-born and US-born Hispanic women.

For Asian and Pacific Islander women, in contrast, we find much stronger evidence of the hypothesized protective effect of racial isolation. Living in a neighborhood that is isolated from Hispanics (though not from blacks or whites) predicts a substantially reduced odds of low birth weight. Furthermore, Asian/Pacific Islander women experience the only consistent association between decreasing levels locally-measured racial/ethnic diversity and improved birth outcomes. Taken together, these findings are highly suggestive of a so-called ethnic enclave effect. Though isolation from whites and blacks had no protective association with low birth weight, we believe that the former finding is one of neutrality, while the former is one of geographic distance and probability. Asians and Pacific Islanders in multiple studies are least likely to want to live with blacks (Charles, 2009); in conjunction with the fact that each group makes up around 10% of the population, and the centers of their respective populations are on opposite sides of the city, there may be very little interaction between these groups from a residential perspective, making the likelihood of impact on pregnancy outcomes low. It is reasonable that only Hispanic isolation would matter, as Hispanics represent the group with which Asians are mostly likely to interact on a daily basis. It also appears that the protective effect of residence with other Asian/Pacific Islanders operates through a decreased likelihood of having appropriate for gestational age low birth weight infants. This is an interesting finding, suggesting that ethnic co-residence may have a role in decreasing susceptibility to inflammatory response – perhaps the role of so-called ethnic enclaves as buffers against social stress reduces the reactivity of women's bodies to insults which would otherwise cause inflammation. It is also particularly interesting to find that racial isolation may impact pregnancy outcomes for each of the racial and ethnic groups studied in different ways – blacks, through small for gestational age births; Hispanics, through increases in low birth weight globally; and Asians, through decreases in appropriate for gestational age low birth weight.

These findings paint a picture of segregation in Los Angeles County as it pertains to pregnant women from each of three racial and ethnic groups – blacks, Hispanics, and Asian/Pacific Islanders. We find that the landscape of segregation and pregnancy outcomes is complex, and varies for different racial and ethnic groups. As immigration continues, the "color lines" in Los Angeles will continue to shift. We find evidence that Hispanic women's experience of segregation may more closely mirror blacks, which is somewhat unexpected given previous findings. Continued research is needed to both describe these shifts in racial residential segregation and to understand their implications for pregnancy outcomes.

Neighborhood Social Capital and Birth Outcomes

Disadvantaged neighborhoods may "get under the skin" to cause poor health outcomes through a number of mechanisms, but a particularly prominent theory is that decreased social cohesion and increased social disorder may increase stress and poor health among residents (Taylor, Repetti, & Seeman, 1997). Geronimus posited that social, physical and emotional stressors associated with the social context facing women of color contributed to prematurely aging their bodies and producing poor health outcomes (1996). Utilizing detailed neighborhood survey data, we undertook an exploration of neighborhood-level measures of social cohesion, reciprocity, and material conditions to determine if any might predict increases in low birth weight.

Though results were hampered by weak scales, we find that reciprocity has a particularly interesting association with birth outcomes for foreign born women (of any race or ethnicity) and for Hispanic women. Increasing neighborhood reciprocity, or the extent to which neighbors do favors for and ask advice of one another, predicts a decrease in the odds of low birth weight for foreign-born women; in contrast, it predicts a large increase in the odds of low birth weight for Hispanic women. It seems likely that so-called ethnic enclaves may have increased social reciprocity from which foreign-born women may benefit. We struggle, however, to adequately explain the relationship between neighborhood reciprocity and increased odds of low birth weight among Hispanic women. Because foreign-born women are in the model, the effect on Hispanic women is that for US-born Hispanic women, and we can speculate that these women may feel social and emotional stress as a result of expected reciprocity. It is possible that in neighborhoods with higher proportions of foreign born residents and higher levels of social reciprocity, the neighbors, family, and friends of US-born Hispanic women may place high expectations on these women to be liaisons between the barrio and the large social, political, and economic machine of the city. We can only speculate, but this type of social pressure may contribute to a weathering effect for US-born Hispanic women which contributes to poorer pregnancy outcomes in the context of high social reciprocity.

Though we expected to find that safety concerns and social cohesion would have associations with birth outcomes for all women, we found an association between fear of violence and poorer pregnancy outcomes only for white women. Others have found that the perceived violence or safety in a neighborhood may be closely related to the proportion of people of color living in that neighborhood (irrespective of objective measures of crime or violence) (Elo, Mykyta, Margolis, & Culhane, 2009). It is possible that whites have a heightened perception of unsafe neighborhood conditions that contributes to this detrimental effect.

Overall, the findings from the neighborhood-level measures of social capital indicate that for certain groups, measures of social reciprocity may have an association with birth outcomes. Further research is needed to better understand the measurement and association of these constructs at the neighborhood level, and which elements of social capital may be most important for low birth weight outcomes. Given the results from this and the first paper, we suspect that further research will reveal that measures of social capital have different associations with low birth weight for different racial and ethnic groups in Los Angeles.

Addressing Racial Inequities in Birth Weight: Evaluating Preconception Care

If the findings from our analyses and those of many others in the field are to be believed, social context shapes our health choice and chances, and inequities in the social context become manifest in inequities in health outcomes such as low birth weight (Green & Darity, 2010; Sastry & Hussey, 2002; Williams, 2002; Williams & P. B. Jackson, 2005). Preconception care, as a clinical and health behavior-focused intervention and policy prescription, is unlikely to fundamentally alter racial and ethnic disparities and health. We must find clearer, more integrated ways of addressing women's health that do help them become healthier prior to pregnancy but that do not require a reliance on individual change, over-stating risk, and further fragmenting women's health care.

Conclusions

Our analyses suggest that racially segregated neighborhoods matter for pregnancy outcomes; the social inequities caused by the racialized geography of our cities are manifest in the low birth weight outcomes of disadvantaged and marginalized women. Furthermore, in the face of persistent racial inequities in birth outcomes, public health approaches which address only clinical and individualized risk structures will fail to alter the distributional landscape which will hold open the gap between black and white women's birth outcomes. We must begin to look upstream, to altering the forces which shape social context of women's lives, in order to close the gap. As we do so, however, we must be mindful of the dynamic nature of place and context; action in one arena may have unintended consequences in another, which a dynamic view of social context and social space may help us to anticipate.

In describing health policy approaches to addressing health inequalities, Graham insists on the separation of the fundamental social causes of disease and the mechanisms by which they are distributed as a means for understanding policy implications (Graham, 2004). In the absence of addressing one or the other, we may inadvertently exacerbate the problems we seek to solve. Many current public health models encourage linear thinking from neighborhood to health outcome, rather than a dynamic process of change and resistance to change. For instance, in a recent model linking social environment to birth outcomes, implementing a policy to improve the physical environment should improve individual health behaviors and social support, which would lead to decreased maternal stress, preterm birth, low birth weight, and infant mortality (Culhane & Elo, 2005).

This same policy, however, may result in displacement of disadvantaged individuals away from the new resources. The neighborhood itself may see improved birth outcomes, but through a transition in the people living there as opposed to improving the original residents' birth outcomes. The conceptual model of place as a distributional landscape provides a mechanism for understanding and perhaps anticipating the complex system of feedbacks and relationships operating in places. Policymakers advocating simply adding more resources may find that those resources flow rapidly away from those locations in which they are most needed unless additional steps are taken to alter the topography. If place contributes to the differential distribution of resources for health, then re-shaping health via these resources requires attention not only to the resources themselves, but to the shape of the landscape.

While the cross-sectional analyses we report here cannot provide a dynamic view of place, they do begin to add nuance to the landscape, which may aid in understanding the distribution of low birth weight among racial and ethnic groups in the US. Future work should seek to build upon our understanding of place and health, developing longitudinal models of neighborhood change and individual behaviors that can give further insight into how neighborhoods (and in this case, segregated neighborhoods) can contribute to poor birth outcomes and the persistence of inequities in low birth weight outcomes.

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