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Neighborhood conditions are associated with maternal health behaviors and pregnancy outcomes

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ABSTRACT

Women residing in neighborhoods of low socioeconomic status are more likely to experience adverse reproductive outcomes; however, few studies explore which specific neighborhood features are associated with poor maternal health behaviors and pregnancy outcomes. Based upon our conceptual model, directly observed street-level data from four North Carolina US counties were used to create five neighborhood indices: physical incivilities (neighborhood degradation), social spaces (public space for socializing), walkability (walkable neighborhoods), borders (property boundaries), and arterial features (traffic safety). Singleton birth records (2001–2005) were obtained from the North Carolina State Center for Vital Statistics and maternal health behavior information (smoking, inadequate or excessive weight gain) and pregnancy outcomes (pregnancy-induced hypertension/pre-eclampsia, low birthweight, preterm birth) were abstracted. Race-stratified random effect models were used to estimate associations between neighborhood indices and women's reproductive behaviors and outcomes. In adjusted models, higher amounts of physical incivilities were positively associated with maternal smoking and inadequate weight gain, while walkability was associated with lower odds of these maternal health behaviors. Social spaces were also associated with inadequate weight gain during pregnancy. Among pregnancy outcomes, high levels of physical incivilities were consistently associated with all adverse pregnancy outcomes, and high levels of walkability were inversely associated with pregnancy-induced hypertension and preterm birth for Non-Hispanic white women only. None of the indices were associated with adverse birth outcomes for Non-Hispanic black women. In conclusion, certain neighborhood conditions were associated with maternal health behaviors and pregnancy outcomes.

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Introduction

Research in the United States, which mostly employs census data to define both neighborhood conditions and boundaries, has found consistent modest associations (after adjustment for individual-level variables) between neighborhood deprivation and preterm birth (Holzman et al., 2009; Messer et al., 2008; O'Campo et al., 2008), low birthweight (Nkansah-Amankra, Luchok, Hussey, Watkins, & Liu, 2010; Schempf, Strobino, & O'Campo, 2009), small-for-gestational age (Elo et al., 2009; Farley et al., 2006) and neural tube defects (Grewal, Carmichael, Song, & Shaw, 2009; Wasserman, Shaw, Selvin, Gould, & Syme, 1998). Similar associations have been found in studies across Europe (Agyemang et al., 2009; Gray et al., 2008; Gudmundsson, Bjorgvinsdottir, Molin, Gunnarsson, & Marsal, 1997; Janghorbani, Stenhouse, Millward, & Jones, 2006; Vrijheid et al., 2000).

In addition to understanding the influence of neighborhood characteristics on birth outcomes, there is also interest in identifying neighborhood conditions that influence maternal health behaviors which could be on the causal pathway between neighborhood environments and pregnancy outcomes. Recent studies have shown that neighborhood characteristics may affect birthweight through the neighborhood's effects on maternal behaviors, such as smoking (Schempf et al., 2009) and inappropriate weight gain (Laraia, Messer, Evenson, & Kaufman, 2007). Explicating the ways through which neighborhoods influence health behaviors and outcomes is important for identifying the policy-relevant,

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modifiable neighborhood characteristics to which scarce public health resources can be applied.

Estimating a woman's residential environment with aggregated census variables does not necessarily represent the physical and social attributes of a neighborhood. In an effort to capture neighborhood-level attributes besides those possible using census data, a number of investigators have collected directly observed neighborhood characteristics. Because the number of neighborhood attributes available for observation is nearly infinite, we turned to the land use and planning literature as well as crime and safety literature to guide our data collection. From the criminology literature, Perkins, Meeks, and Taylor (1992) hypothesized that physical evidence of neighborhood degradation, including markers of "physical incivilities" (e.g., litter, graffiti, poor housing conditions), would undermine the confidence that residents have in their neighbors and community, thus increasing the fear of crime and associated stress; whereas physical signs of property demarcation through hedges, fences and decorations ("borders") symbolically convey to outsiders that area residents maintain and communicate control over their property. From land use and planning literature, researchers have suggested that providing public space for socializing ("social spaces") and walkable neighborhoods with aesthetic qualities and destinations ("walkability"), that maximize traffic and pedestrian safety ("arterial features") all promote travel and leisure physical activity, which are important for health (Evenson et al., 2009; Frank, Schmid, Sallis, Chapman, & Saelens, 2005).

Prior work conducted by the authors explored preliminary associations between three of these literature-based neighborhood attributes and pregnancy-related health behaviors (but not birth outcomes) within a smaller pregnancy cohort on a limited geographic scale (Laraia et al., 2007). Laraia et al. found that higher levels of physical incivilities were inversely associated with physical activity and higher levels of social spaces were related to lower odds of inappropriate weight gain, but no associations were found between territoriality and health behaviors.

Derived from the cited literature and prior work, the conceptual model underlying this research hypothesized that women are exposed to multiple neighborhood-level health promoting and impairing influences, including incivilities, borders, social spaces, walkability and arterial features. We further anticipated these variables would differ in their magnitude and direction of association with adverse health behaviors and birth outcomes. Our conceptual model posited higher levels of physical incivilities and arterial features would be associated with worse pregnancy-related health behaviors and outcomes whereas borders, social spaces and walkability indicators would be associated with better health behaviors and outcomes. We believe that exposure to indicators of physical incivilities would result in increased psychosocial stress and may be associated with both individual- and neighborhood-level poverty, which has been associated with adverse pregnancy-related behaviors and outcomes. Access to increased social spaces may encourage healthy behaviors, increase the likelihood of neighborhood-level social interactions during pregnancy and increase perceived social support among expectant women. The presence of borders is thought to be associated with favorable maternal health behaviors and birth outcomes through its hypothesized influence on a woman's feeling of security through defined personal space and ownership. Neighborhood walkability should facilitate positive maternal health behaviors by providing a safe space within which healthy behaviors may occur. However, arterial features relate to heavy vehicular traffic and less pedestrian-friendly attributes of a neighborhood. Areas with paved roads, bus traffic, and streets made up of multiple lanes, with the need for crosswalks and other pedestrian-friendly markings due to the traffic volume, are hypothesized to be negatively related to pregnancy-related behaviors and outcomes due to high traffic volume being associated with greater risk of accidents and stress.

Based on the published literature, which guided our construct selection, prior work, which suggested interesting associations to pursue within a larger and more geographically diverse sample, and our conceptual model, the objective of this work was to identify the associations between these five neighborhood indices and maternal health behaviors and birth outcomes independent of individual-level characteristics.

Methods

This geographically-defined cohort study combined directly-observed street-level data with five years of birth records data from four counties in North Carolina (NC). Five neighborhood indices were constructed based on previously identified measures (Evenson et al., 2009; Laraia et al., 2007), and associations between these indices and maternal health behaviors and outcomes were estimated. *A priori* we decided to stratify the statistical analyses by race, as neighborhood effects have been differentially associated with white and black women's birth outcomes in the literature (Gorman, 1999; O'Campo et al., 2008; Pickett, Ahern, Selvin, & Abrams, 2002; Savitz et al., 2004). Ethical review was completed at the University of North Carolina.

Population description

Birth records for the four counties in which most of the third Pregnancy, Infection, and Nutrition (PIN3) Study participants resided were obtained from the NC State Center for Vital Statistics for 2001–2005. Over 39,000 singleton births to Non-Hispanic (NH) white and black women with geocodable addresses were included in the study. Infants with improbable gestational ages (less than 22 weeks, greater than 42 weeks), infants with improbable birthweights (less than 500 g, greater than 6000 g), and infants for whom a stillbirth outcome could not be precluded (infants with a gestational age of 22–25 weeks without birthweight information) were excluded ($n = 167$). The residential address provided on the birth certificate was geocoded and used to assign each woman to a census block group.

Outcome definitions

Information on pregnancy-related behavioral risk factors (smoking and maternal weight gain) and outcomes (pregnancy-induced hypertension/eclampsia, low birthweight, and preterm birth) were obtained from birth certificates. These pregnancy-related behavioral factors and outcomes were chosen, in part, because they have previously been shown to be reliably reported on birth certificates (Vinikoor, Messer, Laraia, & Kaufman, 2010). Other behaviors and outcomes, such as alcohol consumption and anemia, were not considered because the birth certificate data appear unreliable (Vinikoor et al., 2010). The behavior of smoking during pregnancy was categorized as present or absent for each woman. Weight gain was categorized based on the 1990 Institute of Medicine cutpoints for adequate gestational weight gain (Institute of Medicine, 1990). Because pre-pregnancy weight status is not recorded on the birth certificate, we used general cutpoints for inadequate ($<$15 lbs) and excessive ($\geq$40 lbs) weight gain as these apply to any pre-pregnancy weight. Pregnancy-induced hypertension/eclapmsia (hereafter referred to as PIH) was classified as having either condition present or absent during pregnancy. Gestational age was determined using information on last menstrual period when this information was complete; clinical estimates were used when data elements to calculate gestational