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RESEARCH ARTICLE

Street Connectivity and Obesity Risk: Evidence From Electronic Health Records

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Introduction: This study aimed to determine the feasibility of using electronic health record (EHR) data from a federally qualified health center (FQHC) to assess the association between street connectivity, a measure of walkability for the local environment, and BMI obtained from EHRs.

Methods: The study included patients who visited Daughters of Charity clinics in 2012–2013. A total of 31,297 patients were eligible, of which 28,307 were geocoded. BMI and sociodemographic information were compiled into a de-identified database. The street connectivity measure was intersection density, calculated as the number of three-way or greater intersections per unit area. Multilevel analyses of BMI, measured on 17,946 patients who were aged $\geq$20 years, not pregnant, had complete sociodemographic information, and a BMI value that was not considered an outlier, were conducted using random intercept models.

Results: Overall, on average, patients were aged 44.1 years, had a BMI of 30.2, and were mainly non-Hispanic black (59.4%). An inverse association between BMI and intersection density was observed in multilevel models controlling for age, gender, race, and marital status. Tests for multiple interactions were conducted and a significant interaction between race and intersection density indicated the decrease in BMI was strongest for non-Hispanic whites (decreased by 2) compared with blacks or Hispanics (decreased by 0.6) (p=0.0121).

Conclusions: EHRs were successfully used to assess the relationship between street connectivity and BMI in a multilevel framework. Increasing street connectivity levels measured as intersection density were inversely associated with directly measured BMI obtained from EHRs, demonstrating the feasibility of the approach.
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INTRODUCTION

Despite growing awareness of the negative health impact of poor diet, physical inactivity, and excess weight, the prevalence of obesity has increased dramatically in the U.S.[1,2] During the last 3 decades, the U.S. obesity rate has doubled in adults and tripled in children and adolescents.[1] The consensus among public health experts is that human genetic changes are not responsible for the rapid rise in obesity and the explanation must lie in social determinants resulting from environmental and policy changes.[3–6]

Although there is consensus on the general role of social, physical activity, and food environments in contributing to the epidemic, there is little in the way of consensus on the relative contribution of any one social determinant (e.g., stressful environment, food deserts, concentrated disadvantage), let alone the relative contribution of any specific neighborhood or community context (e.g., fast food outlet density, walkability).[7–10] It

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has been recognized that the lack of data measured at a scale sufficient to assess the role of the neighborhood environment is a real limitation.[11] For example, the two main U.S. public health surveillance systems, with a sufficient number of participants to assess the role of the environment, are limited in their capacity for assessing neighborhood risk. The Behavioral Risk Factor Surveillance Survey, despite covering the entire U.S., uses self-reported measures of diet and physical activity and is organized with the smallest areal unit being county.[12,13] The National Health and Nutrition Examination Survey, on the other hand, directly measures diet and physical activity, but is organized to provide surveillance estimates at the national or regional level.[14] By contrast, the Affordable Care Act and the Health Information Technology for Economic and Clinical Health Act have made possible the conversion to electronic health records (EHRs) for most federally qualified health centers (FQHCs).[15] This has created a situation where large volumes of clinical data can be spatially organized to potentially study the role of the neighborhood environment on a variety of outcomes, including obesity risk.[16] The purpose of this study is to assess the feasibility of obtaining and using EHR data from an FQHC in order to assess the association between a measure of the local environment and obesity-related outcomes in a multilevel framework.

A review of the health literature found only two studies in which health providers' patient data were used to characterize obesity risks associated with neighborhood context. Oreskovic and colleagues[17] geocoded by residence children (i.e., those aged 2–18 years) enrolled in Partners HealthCare, a healthcare network in eastern Massachusetts. The study focused on transportation measures and, of the eight studied measures, only number of subway stations within a child's neighborhood showed a statistically significant inverse association with BMI. Drewnowski et al.[18] studied obesity in adults enrolled in Group Health, a nonprofit healthcare provider for King County, Washington. Neighborhood was defined in terms of Census tract of residence. Area-based sociodemographic measures were obtained from the U.S. Census. Median home value, percentage college educated, and median household income at the Census tract level were found to be inversely associated with obesity.

One factor that has been consistently linked to obesity risk in studies of neighborhood context is neighborhood walkability. One of the measures used to assess walkability is street connectivity. However, the association with obesity in general and physical activity in particular have not always been consistent.[19–23] With this limitation in mind, the current study attempted to assess the feasibility of using directly measured data assessing obesity risk (i.e., BMI) obtained from EHRs.

The possibility of using EHR data was made possible through a community partnership established as part of the Mid-South Transdisciplinary Collaborative Center. The Social Determinants of Health core of the Mid-South Transdisciplinary Collaborative Center had been working with a community-based health provider in the New Orleans area, Daughters of Charity (DOC), when the possibility of spatially organizing their patient population was discussed. DOC clinics needed the information to better characterize their patient population in terms of residence in at-risk neighborhoods.

METHODS

The present study included patients who resided in Louisiana and visited DOC clinics in calendar years 2012–2013. DOC clinics are FQHCs serving primarily poor and minority residents in the greater New Orleans area. DOC have provided care in the New Orleans area for >175 years at five clinic sites (Figure 1). The clinics provide primary and preventive care, pediatrics, women's health, behavioral health, Special Supplemental Nutrition Program for Women, Infants, and Children, and dental services. More-detailed information is available at their website (http://dcsno.org). Geographic, demographic, and clinical data are available through EHRs required for FQHCs through the Affordable Care Act. The present study was approved by the IRB of Louisiana State University Health Sciences Center.

Geocoding

The home address listed in the patient record at their last clinic visit within the 2012 and 2013 calendar years was used for geocoding. Geocoding was carried out using Esri ArcMap, version 10.2, using a U.S. street address locator. The road network data used to build the address locator were based on the StreetMap North America, which contains 2005 Tele Atlas street data and were enhanced by both Esri and Tele Atlas. Patients without a home address or with a PO box for a home address were excluded from the study. In addition, addresses included were restricted to those with a matching score ≥ 80. A total of 31,297 patients were eligible to be included in the study. Within the eligible sample, 27,659 patients' addresses were matched by the aforementioned software and 648 were manually matched, for a total of 28,307 patients who were geocoded and assigned to a Census tract (90.4% matching). The remaining 2,990 addresses did not match because the address was not found (n=1,662 [55.6%]), was incomplete (n=735 [24.6%]), consisted of a PO box only (n=568 [19.0%]), or some other issue (n=25 [0.8%]). Subsequently, the 28,307 geocoded patients were assigned a randomly generated Census tract ID, which could be linked to the Census tract–level variables to preserve the multilevel structure of the data but simultaneously allowed for removal of the actual Census tract identifier. Furthermore, patients whose address was geocoded were also assigned a randomly generated personal ID. All data were managed and analyzed on DOC computers to preserve confidentiality.

Measures

Available self-reported demographic information, such as gender (female or male), race/ethnicity (non-Hispanic black or non-Hispanic white or Hispanic), age at visit, and marital status (married or not married), on patients whose addresses were