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Neighborhood characteristics, food deserts, rurality, and type 2 diabetes in youth: Findings from a case-control study

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ABSTRACT

Little is known about the influence of neighborhood characteristics on risk of type 2 diabetes (T2D) among youth. We used data from the SEARCH for Diabetes in Youth Case-Control Study to evaluate the association of neighborhood characteristics, including food desert status of the census tract, with T2D in youth. We found a larger proportion of T2D cases in tracts with lower population density, larger minority population, and lower levels of education, household income, housing value, and proportion of the population in a managerial position. However, most associations of T2D with neighborhood socioeconomic characteristics were attributable to differences in individual characteristics. Notably, in multivariate logistic regression models, T2D was associated with living in the least densely populated study areas, and this finding requires further exploration.

1. Introduction

Social determinants of health are receiving increasing attention, as health systems are trying new approaches to preventive care (Rubin et al., 2015; Garg et al., 2013). The World Health Organization defines social determinants of health as "the conditions in which people are born, grow, work, and age," (WHO, 2017) emphasizing the educational, economic, social, health-care, and neighborhood contexts in which people live (Office of Disease Prevention and Health Promotion, 2017). Similar to obesity and cardiovascular disease, type 2 diabetes mellitus (T2D) in adults is a chronic disease that is well known to be associated with poverty, deprivation, and lower socioeconomic status (SES) (Connolly et al., 2000; Schlundt et al., 2006; Grigsby-Toussaint et al., 2010; Diez-Roux et al., 2002; Cubbin et al., 2006; Krishnan et al., 2010).

It was not until the last two decades that T2D began to emerge among youth (< 18 years old), and there is now evidence that the incidence and prevalence of T2D have in fact been increasing in youth populations: a 4.8% annual rise in incidence was reported between 2002 and 2012 by the SEARCH for Diabetes in Youth Study (Mayer-Davis et al., 2017), which conducts surveillance in five study centers in the United States (US), with marked increases seen particularly among youth of minority race/ethnicity (Mayer-Davis et al., 2017; Dabelea et al., 2014; Pettitt et al., 2014; Liese et al., 2006). The SEARCH study reported a prevalence of T2D of 0.46 per 1000 youth age 10–19 in 2009, a 35% relative increase compared to 2001 (Dabelea et al., 2014). In combination with the documented higher levels of health complications among youth with T2D (Maahs et al., 2007; Albers et al., 2008; Petitti et al., 2009; Liu et al., 2010; Wadwa et al., 2010; Dabelea et al., 2017), these alarming trend statistics emphasize a need to investigate the risk factors associated with T2D, including consideration of root causes such as social determinants of health.

The focus of research on risk factors for T2D in youth to date has been on individual-level attributes that are thought to influence the nutritional and obesity-related risk factors for T2D (Mayer-Davis et al., 2008; Dabelea et al., 2008; Braun et al., 1996; Jerrell et al., 2012). A recent case-control study of T2D in youth age 10–17 years based on

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secondary data conducted in Manitoba, Canada, reported that gestational and pre-gestational diabetes in mothers were both associated with increased T2D risk among youth (Halipchuk et al., 2017). This study and others also found that breastfeeding of infants was associated with markedly decreased risk (Mayer-Davis et al., 2008; Dabelea et al., 2008). In addition, maternal obesity during pregnancy has also been shown to be associated with increased risk of T2D (Dabelea et al., 2008).

However, very little conclusive evidence exists for factors that could be considered social determinants of risk for T2D in youth. One of the above-mentioned studies showed that low maternal income was associated with increased T2D risk among youth (Halipchuk et al., 2017). An analysis of the Chicago Childhood Diabetes Registry from 1994 to 2003 and census-based data on household income on neighborhoods from 1970 to 2000 found that neighborhoods with mostly African-American residents and persistently high poverty levels over time exhibited an increased risk of non–type 1 diabetes in youth compared to neighborhoods that were classified as having stable income diversity (defined as having a socioeconomically diverse population over 30 years) (Grigsby-Toussaint et al., 2010). In a multicenter study of young adults, neighborhood socioeconomic disadvantage was associated with higher insulin resistance syndrome scores (Diez-Roux et al., 2002).

There is a substantial literature describing rural-urban disparities in T2D in adults, with higher prevalence of diabetes in rural than in urban areas (Krishna et al., 2010; Trivedi et al., 2015, 2013; Agency for Healthcare Research and Quality, 2017; O'Connor and Wellenius, 2012). However, very little is known about the association of rurality with T2D in youth. One study of children age 2–11 years reported a significantly higher prevalence of overweight and obesity in rural compared to urban children that was not explained by socioeconomic status or by dietary or physical activity behaviors (Liu et al., 2012), and these findings have been confirmed in other US-based studies (Johnson and Johnson, 2015). It is not clear what obesity-related behaviors may underlie these associations, as rural children seem to consume more calories per day yet also participate in more exercise (Liu et al., 2012). A case control study in Manitoba, Canada, reported equivalent and high proportions of T2D cases and controls residing in rural areas (71% for both groups) and thus did not provide evidence for rurality as a risk factor for T2D (Halipchuk et al., 2017).

The concept of a “food desert” has emerged recently, defined by the USDA as “a low-income census tract where either a substantial number or share of residents has low access to a supermarket or large grocery store.” (United States Department of Agriculture Economic Research Service, 2013; Ver Ploeg, 2009) Residents of food deserts have been shown to travel significantly farther to their grocery store (Sohi et al., 2014). One mechanism that may explain the reported association of food deserts with obesity (Chen et al., 2016) is that farther travel may be associated with lower shopping frequency, which has in turn been linked to lower fruit and vegetable intake (Liese et al., 2014). Therefore, it is conceivable that residing in a food desert, similar to other low-SES areas, may be a risk factor for the development of T2D in youth.

Thus, the aim of our study was to evaluate the association of multiple neighborhood SES characteristics, considered separately and jointly (Liese et al., 2012), rurality, and residing in a USDA-designated food desert, with T2D in ethnically and geographically diverse youth using data from a case-control study of T2D (Mayer-Davis et al., 2008; Dabelea et al., 2008; Liese et al., 2012).

2. Materials and methods

Study procedures were reviewed and approved by the institutional review boards of the participating institutions, including compliance with the Health Insurance Portability and Accountability Act (HIPAA).

2.1. SEARCH for Diabetes in Youth Study

The SEARCH for Diabetes in Youth Study was a six-center (Ohio, Colorado, Washington, South Carolina, Hawaii, and California) observational study that began conducting population-based ascertainment of non-gestational cases of diagnosed diabetes in youth < 20 years of age in 2001 (prevalent cases) and 2002 (incident cases) and is ongoing. Details of the SEARCH Study design have been published (SEARCH Study Group, 2004; Hamman et al., 2014). All eligible cases of diabetes were identified based on networks of pediatric and adult endocrinologists, existing pediatric diabetes databases, hospitals, databases of health plans, and other health-care providers. Case reports were validated through physician reports, medical record reviews, or, in a few instances, self-report of a physician's diagnosis of diabetes (SEARCH Study Group, 2004). Diabetes type, as assigned by the health-care provider, was categorized as type 1 (T1D) (combining types 1, 1a, and 1b), T2D, and other (including hybrid, maturity onset of diabetes in youth, type designated as “other,” type unknown by the reporting source, and missing). The present analysis focuses on cases of T2D.

Case reports were registered anonymously with the Coordinating Center at Wake Forest University in North Carolina using HIPAA-compliant procedures. Identifying information was retained at each field site.

2.2. SEARCH case-control study

The SEARCH Case-Control (SEARCH-CC) Study was an ancillary study to SEARCH, conducted at two (Colorado and South Carolina) of the six clinical sites (Mayer-Davis et al., 2008; Dabelea et al., 2008; Liese et al., 2012). Between July 2003 and March 2006, 119 T2D cases ≥10 years of age attended in-person study visits. For the purposes of the SEARCH-CC Study, eligibility of cases was restricted to (i) four counties surrounding the city of Columbia, South Carolina (Richland, Lexington, Orangeburg, and Calhoun) for prevalent cases in 2001 and statewide for incident cases in subsequent years and (ii) selected counties in Colorado (seven counties encompassing the Denver metropolitan area: Adams, Arapahoe, Boulder, Denver, Douglas, Jefferson, and Weld) for prevalent cases in 2001 and incident cases statewide in subsequent years. Control participants were concurrently recruited from primary care offices following the rationale that all SEARCH cases arose from health-care provider offices. Participating primary care offices provided an initial study brochure, and patients and their parents/guardians were asked to complete a one-page information form and an indication of permission for study staff to contact them. Of 1203 information forms returned by participating practices, 881 (73.2%) patients indicated interest in learning about the study. Of these, 41 were ineligible, 233 later refused explicitly, 389 could not be successfully contacted (passive refusals), and 218 participated as controls in SEARCH-CC. All controls were confirmed as not having diabetes by fasting glucose values obtained during the clinic visit. More extensive details of the SEARCH-CC Study methods have been published (Mayer-Davis et al., 2008).

2.3. Individual-level socioeconomic and clinical characteristics of cases and controls

Variables such as age at clinic visit, race/ethnicity, gender, parental education, and household income were obtained for T2D cases as part of SEARCH and for non-diabetic controls as part of SEARCH-CC. Race/ethnicity was categorized as non-Hispanic white versus African American or Hispanic; the latter two groups were combined because there were only five Hispanic T2D cases and four Hispanic control participants. Parental education (parent with the highest education) was categorized as less than high school and high school education or above. Income was categorized as < $25,000, $25,000–74,999, and ≥$75,000. Data collec-