Social Science & Medicine 183 (2017) 126–129

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Short communication

Neighborhood disorder and glycemic control in late adolescents with Type 1 diabetes

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ARTICLE INFO

Article history:
Received 29 August 2016
Received in revised form
10 April 2017
Accepted 28 April 2017
Available online 30 April 2017

Keywords:
Neighborhood disorder
Adolescents
Type 1 diabetes
Subjective social status

ABSTRACT

Objective: To evaluate the contribution of neighborhood characteristics to treatment adherence and glycemic control in late adolescents with Type 1 diabetes.
Research design and methods: As part of a larger study, 220 late adolescents with Type 1 diabetes (aged 17.8 ± 0.4 years, 59.6% female, diabetes duration 7.3 ± 3.9 years) were recruited from outpatient pediatric clinics during their senior year of high school. Adolescents completed self-report measures of adherence behaviors and subjective social status, and their HbA1c values were collected during a lab assessment. Their mothers reported on their own educational achievement. These data were linked with neighborhood characteristics obtained from 2010 American Community Survey data using participants' home addresses. Based on previous work (Dulin-Keita et al., 2012), a neighborhood disorder composite score was computed from Census-tract-level variables, including percent of the population achieving less than a high school education, under 18 who lived in poverty, unemployed, receiving public assistance, and percent of households that were vacant.
Results: – Adolescents with Type 1 diabetes who lived in more disordered neighborhoods were at higher risk for poorer glycemic control ($p < .001$), but did not report poorer adherence behaviors. The association between neighborhood disorder and HbA1c was significant after accounting for family socioeconomic status (maternal education), but not subjective social status.
Conclusions: – Results highlight the importance of neighborhood disorder for adolescents' glycemic control. The nonsignificant association between neighborhood disorder and adherence behaviors suggests physiological rather than behavioral mechanisms may be driving neighborhood SES-health outcome links.

1. Introduction

Characteristics of individuals' neighborhoods have important implications for their health. Neighborhood characteristics, including poverty rates and educational achievement, have been linked to such health indicators as cortisol levels (Dulin-Keita et al., 2012; Karb et al., 2012), blood pressure, and BMI (Chen and Paterson, 2006). Neighborhood characteristics may also be associated with aspects of Type 1 diabetes management. Those living in less advantaged neighborhoods typically have limited access to health care, healthy foods, and safe recreation areas (Diez Roux, 2001; Steptoe and Feldman, 2001), and have higher levels of chronic stress (Leventhal and Brooks-Gunn, 2000; Steptoe and Feldman, 2001; Xue et al., 2005), all of which may have implications for Type 1 diabetes management. These neighborhood characteristics reflect stressful experiences that may be associated with poorer glycemic control, though it is uncertain as to whether these experiences directly influence the neuroendocrine system or if they alter glycemic control through poorer adherence behaviors (Lloyd et al., 1999). Although links have been established between various social resources (e.g., income, parental education; Borschuk and Everhart, 2015; Naar-King et al., 2006) and diabetes management, the role of the larger neighborhood environment has not been considered. It is important to understand if adolescents in disordered neighborhoods exhibit different glycemic control

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http://dx.doi.org/10.1016/j.socscimed.2017.04.052
0277-9536/

compared to adolescents in more ordered neighborhoods to illuminate the likely mechanisms for disparities in diabetes trajectories for these cohorts. The goal of the present study was to examine the contribution of neighborhood characteristics to glycemic control (HbA1c; levels of glycosylated hemoglobin over the past 2–3 months) and adherence (measured with a self-report questionnaire) in a sample of late adolescents (high school seniors, ages 17–19) living with Type 1 diabetes.

Research in healthy adolescent samples (Chen and Paterson, 2006) has demonstrated that neighborhood characteristics predict adolescents' health even after considering family socioeconomic factors and subjective social status. Specific to Type 1 diabetes, a recent literature review (Borschuk and Everhart, 2015) revealed that family-level indicators of SES inform diabetes outcomes. Greater household income, more parental education, having health insurance and higher ranked parental occupation were related to better HbA1c values. Knowing the larger context of the neighborhood environment (e.g., poverty level, educational achievement of neighborhood residents, structural aspects) may reveal that when adolescents lack economic and social resources and encounter neighborhood disorder and disadvantage, they experience poorer diabetes management over and above family- and individual-level indicators.

The construct neighborhood disorder and disadvantage (hereafter referred to as neighborhood disorder) (Dulin-Keita et al., 2012), which captures several dimensions of the neighborhood environment, was utilized to understand the contribution of neighborhoods on Type 1 diabetes management. Neighborhood-level data from the 2010 American Community Survey (ACS) were linked to data collected on adolescents' HbA1c levels and adherence behaviors. Following previous work (Dulin-Keita et al., 2012), neighborhood disorder was created by combining five Census-derived neighborhood characteristics. The relationship between neighborhood disorder and diabetes management was examined before and after controlling for family (maternal education) and individual indicators (subjective social status) in order to understand whether neighborhood disorder contributed to indicators of diabetes management over and above traditional individual- and family-level socioeconomic measures. Following results from previous studies on neighborhoods and health indicators (Chen and Paterson, 2006), it was predicted that increased neighborhood disorder would be uniquely associated with higher HbA1c levels and poorer adherence.

2. Methods

2.1. Research design

High school seniors with Type 1 diabetes were recruited from outpatient pediatric clinics either in-person or over the phone. Of the qualifying 507 individuals approached, 301 (59%) initially agreed to participate, and 247 were subsequently enrolled. Adolescents were eligible if they had been diagnosed with Type 1 diabetes for at least one year, had English as their primary language (required for neurocognitive testing in the larger study), were in their final year of high school, lived with a parent, and had no condition that would prohibit study completion. Adolescents and parent(s) completed an in-person research session where informed consent/assent was obtained, followed by an online survey. Study procedures were approved by Institutional Review Boards at the University of Utah and the University of Texas Southwestern Medical Center. The present study included respondents who completed baseline measures and for whom Census data were available. Due to changes in Census tracts or non-inclusion in the ACS, neighborhood characteristic data were not available for 21 participants. Additionally, two participants were missing maternal education data and 12 subjective social status. Six participants were missing HbA1c data and 14 were missing adherence scores. Missingness was also present in covariates, with 10 participants not reporting ethnicity and or race. Analyses used all available data, and the results include the number of participants in each model.

2.2. Predictors

Neighborhood disorder. Participant home addresses were used to determine individuals' Census tract in order to link ACS data. Census tracts are neighborhood areas determined by the U. S. Bureau of Census that are more localized and granular than ZIP code tabulation areas. Census tracts generally encompass population areas between 1200 and 8000 people (U.S. Census Bureau, 2012), with the spatial area depending on the density of the population. Although tracts are relatively stable, they may split or merge over time due to changes in population growth or decline.

The ACS Census tract-level data included percent of the population: achieving less than a high school education (10.65 ± 10.82%), under 18 who are living in poverty (14.30 ± 13.67%), unemployed (7.12 ± 3.72%), receiving public assistance (1.60 ± 1.50%), and the percent of households that were vacant (6.62 ± 6.41%). These data were selected to represent the SES of the neighborhood population and the physical environment. *Z* scores were computed for each individual ACS item and were summed to create the neighborhood disorder composite ($\alpha = .75$). Higher neighborhood disorder scores indicated neighborhoods with greater disadvantage compared to other neighborhoods in the sample (range −5.33 to 18.94).

Maternal education. Family SES was obtained from online surveys completed by adolescents and their mothers. Mothers reported the highest level of education they achieved from *Some high school or less* to *Professional degree*. For study analyses, this variable was categorized as 0 = less than college and 1 = college or more education.

Subjective social status. Adolescents' subjective social status was obtained using a version of the MacArthur self-anchoring scale, which has been shown to reflect traditional SES measures (Adler and Stewart, 2007). Adolescents were given a picture of a numbered 10-rung ladder and asked to indicate on which rung they thought they stood at that time relative to others in their community. Higher rungs indicated higher social standing (see Goodman et al. (2001) for work with adolescent samples).

Covariates. Each model included control variables for test site (0 = Utah, 1 = Texas), insulin pump status (0 = no pump, 1 = pump), diagnosis duration (grand-mean centered), gender (0 = female, 1 = male), ethnicity (0 = non-Hispanic, 1 = Hispanic), and race (0 = White, 1 = Other race).

2.3. Outcomes

Glycemic control. Glycated hemoglobin (HbA1c) was indexed from HbA1c assay kits obtained from and processed by CoreMedica Laboratories. Blood samples were collected during the research session and mailed to CoreMedica Laboratories for processing.

Adherence. Adolescents reported on their adherence behaviors in an online survey using the Diabetes Behavior Rating Scale (DBRS; Iannotti et al., 2006), a 37-item measure assessing diabetes management behaviors and problem solving. Higher scores indicated better adherence behaviors. The scale had acceptable reliability ($\alpha = .84$) and has been shown to be moderately and negatively correlated with HbA1c (Iannotti et al., 2006).