Neighborhood Socioeconomic Change and Diabetes Risk

Findings from the Chicago Childhood Diabetes Registry

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OBJECTIVE — To examine whether patterns in socioeconomic characteristics in Chicago over a 30-year period are associated with neighborhood distribution of youth diabetes risk.

RESEARCH DESIGN AND METHODS — Incident cases of diabetes in youth aged 0–17 years were identified from the Chicago Childhood Diabetes Registry between 1994 and 2003. Those with a type 2 diabetes–like clinical course or related indicators were classified as non–type 1 diabetic; the remaining cases were considered to have type 1 diabetes.

RESULTS — Compared with stable diversity neighborhoods, significant associations for type 1 diabetes were found for younger children residing in emerging low-income neighborhoods (relative risk 0.56 [95% CI 0.36–0.90]) and older children residing in emerging high-income neighborhoods (1.52 [1.17–1.98]). For non–type 1 diabetes, older youth residing in desertification neighborhoods were at increased risk (1.47 [1.09–1.99]).

CONCLUSIONS — Neighborhood socioeconomic characteristics in Chicago may be associated with the risk of diabetes in youth.

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In recent years, type 1 and type 2 diabetes have been on the rise in children and adolescents globally (1–5). As the increases in incidence and prevalence of youth diabetes have occurred over a short period of time, genetic factors are unlikely to be solely implicated (1,4,6). Rather, there is growing evidence that social and physical environments influence behavioral and immunologic factors associated with increased type 1 and type 2 diabetes morbidity in youth (7–9). This study explores environmental influences on both type 1 and type 2 diabetes risk in youth using a longitudinal measure of neighborhood socioeconomic context.

RESEARCH DESIGN AND METHODS

Case identification procedures

The Chicago Childhood Diabetes Registry is a city-wide registry of cases of diabetes in youth aged 0–17 years in Chicago, Illinois. Youth included in the registry meet the following criteria: *1*) diagnosis of diabetes based on ICD-9 codes 250.00–250.91, 2) diagnosis on or after 1 January 1985, and *3*) diabetes not secondary to another condition. Youth are classified as non–type 1 diabetic if there was a diagnosis or other evidence of type 2 diabetes, such as type 2 diabetes–like clinical course, treatment with pills or no medications, obesity at diagnosis, polycystic ovary syndrome, or *acanthosis nigricans* (10). Over the study period (1 January 1994 through 31 December 2003), 1,252 patients, representing 92% of registered cases, had complete address and ethnic identity information to be included in the current analysis.

Neighborhood socioeconomic characteristics

An income diversity index, developed by the Metro Chicago Information Center, was used to contextualize neighborhood socioeconomic characteristics. Household income data collected from the U.S. Census between 1970 and 2000 were used to categorize neighborhoods as stable diversity, emerging low income, emerging high income, desertification, and emerging bipolarity (11). Briefly, stable-diversity neighborhoods consist of 19 neighborhoods that have maintained a socioeconomically diverse population between 1970 and 2000. Emerging low-income neighborhoods (n = 11) have experienced a loss of high-income families, while the reverse has occurred with emerging high-income neighborhoods (n = 21), where the majority of low-income families has decreased. Desertification neighborhoods (n = 11) show patterns of entrenched levels of poverty with a predominantly African American population. Finally, emerging bipolarity neighborhoods (n = 15) show an increase in both high- and low-income residents.

Analyses

Year 2000 census counts of children aged 0–17 for each of Chicago's 77 community areas (i.e., neighborhoods) were used to provide denominators for calculating incidence rates. Stable-diversity neighborhoods were used as the referent group for Poisson regression analyses using SAS release 8.02 (SAS Institute, Cary, NC).

RESULTS

Sex

Compared with stable-diversity neighborhoods, significant associations for

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type 1 diabetes were found for male subjects in emerging low-income neighborhoods (relative risk 0.45 [95% CI 0.32–0.64]) and emerging high-income neighborhoods (0.75 [0.57–0.99]). For female subjects, emerging low-income, emerging bipolarity, and emerging high-income neighborhoods were found to be protective (0.61 [0.45–0.84]; 0.74 [0.55–0.99]; 0.71 [0.53–0.95]) for type 1 diabetes (Table 1). For non–type 1 diabetes, male subjects residing in emerging low-income neighborhoods were at 38% lower risk (0.62 [0.39–0.99]) (Table 1).

Age-group

Children aged 0–9 years residing in emerging low-income neighborhoods were at 44% lower risk (0.56 [95% CI 0.36–0.90]) for type 1 diabetes compared with children in stable-diversity neighborhoods. Youth aged 10–17 years residing in desertification (1.38 [1.02–1.87]) and emerging high-income neighborhoods (1.52 [1.17–1.98]), however, were at higher risk for type 1 diabetes (Table 1). For older youth residing in desertification neighborhoods, there was also higher risk for non–type 1 diabetes (1.47 [1.09–1.99]) compared with those from stable-diversity neighborhoods.

Race/ethnicity

Hispanic youth residing in emerging bipolarity neighborhoods had increased risk for both type 1 diabetes (relative risk 1.78 [95% CI 1.78–2.73]) and non–type 1 diabetes (2.15 [1.23–3.77]) (Table 1). Hispanics residing in emerging high-income neighborhoods were also found to have higher risk for non–type 1 diabetes (2.05 [1.15–3.67]). However, in emerging low-income neighborhoods, only non-Hispanic white youth were at higher risk for both type 1 diabetes (2.00 [1.07–3.74]) and non–type 1 diabetes (3.09 [1.07–8.89]) compared with youth in stable-diversity neighborhoods.

CONCLUSIONS — Our results suggest that neighborhood socioeconomic characteristics in Chicago may be associated with the geographic distribution of diabetes risk in youth. The association found between the social environment and diabetes risk in youth is consistent with previous findings by Gopinath et al. (8), who found increased risk for type 1 diabetes in both socioeconomically stable and socioeconomically deprived areas. As our designation of non–type 1 diabetes is more apt to reflect type 2 diabetes, our

Table 1—*Results of Poisson regression by sex, age, and ethnicity*

Category	Relative risk (95% CI)
Sex	
Type 1 diabetes	
Male (*n* = 387)	
Desertification	0.89 (0.63–1.26)
Emerging low income	0.45 (0.32–0.64)*
Emerging bipolarity	0.70 (0.53–0.93)†
Emerging high income	0.75 (0.57–0.99)†
Female (*n* = 378)	
Desertification	0.99 (0.68–1.42)
Emerging low income	0.61 (0.45–0.84)*
Emerging bipolarity	0.74 (0.55–0.99)†
Emerging high income	0.71 (0.53–0.95)†
Non–type 1 diabetes	
Male (*n* = 190)	
Desertification	1.06 (0.67–1.70)
Emerging low income	0.65 (0.41–1.03)‡
Emerging bipolarity	0.75 (0.49–1.14)
Emerging high income	0.62 (0.39–0.99)†
Female (*n* = 297)	
Desertification	1.24 (0.83–1.85)
Emerging low income	0.76 (0.51–1.15)
Emerging bipolarity	1.08 (0.75–1.54)
Emerging high income	0.97 (0.68–1.39)
Age	
Type 1 diabetes	
Age 0–9 years (*n* = 386)	
Desertification	1.14 (0.67–1.97)
Emerging low income	0.56 (0.36–0.90)†
Emerging bipolarity	0.94 (0.67–1.32)
Emerging high income	1.23 (0.91–1.68)
Age 10–17 years (*n* = 379)	
Desertification	1.38 (1.02–1.87)†
Emerging low income	0.93 (0.71–1.24)
Emerging bipolarity	1.07 (0.82–1.39)
Emerging high income	1.52 (1.17–1.98)*
Non–type 1 diabetes	
Age 0–9 years (*n* = 56)	
Desertification	1.90 (0.66–5.48)
Emerging low income	0.68 (0.19–2.43)
Emerging bipolarity	1.02 (0.38–2.76)
Emerging high income	2.18 (0.66–7.14)
Age 10–17 years (*n* = 431)	
Desertification	1.47 (1.09–1.99)†
Emerging low income	1.01 (0.75–1.35)
Emerging bipolarity	1.18 (0.91–1.54)
Emerging high income	1.28 (0.96–1.71)‡
Ethnicity	
Type 1 diabetes	
Black (*n* = 361)	
Desertification	1.02 (0.75–1.38)
Emerging low income	0.94 (0.62–1.42)
Emerging bipolarity	0.90 (0.66–1.21)
Emerging high income	1.37 (0.98–1.92)‡
Hispanic (*n* = 220)	
Emerging low income	1.02 (0.68–1.52)
Emerging bipolarity	1.78 (1.17–2.73)*
Emerging high income	1.37 (0.91–2.08)

(continued)

Table 1—*Continued*

Category	Relative risk (95% CI)
White (n = 184)	
Emerging low income	2.00 (1.07–3.74)†
Emerging bipolarity	0.97 (0.65–1.45)
Emerging high income	1.13 (0.81–1.58)
Non–type 1 diabetes	
Black (n = 320)	
Desertification	1.16 (0.84–1.58)
Emerging low income	1.17 (0.75–1.80)
Emerging bipolarity	1.05 (0.76–1.46)
Emerging high income	1.19 (0.80–1.78)
Hispanic (n = 132)	
Desertification	6.89 (0.92–51.64)‡
Emerging low income	1.44 (0.84–2.48)
Emerging bipolarity	2.15 (1.23–3.77)*
Emerging high income	2.05 (1.15–3.67)†
White (n = 35)	
Emerging low income	3.09 (1.07–8.89)†
Emerging bipolarity	0.52 (0.23–1.14)
Emerging high income	0.76 (0.36–1.58)

*P value <0.001; †$P = 0.01 \leq P$ value ≤ 0.05; ‡$P = 0.05 \leq P$ value ≤ 0.10.

observation that male subjects residing in high-income neighborhoods were at lower risk is consistent with adult type 2 diabetes studies (12). However, the risk for type 1 diabetes was also increased for youth aged 10–17 years in desertification neighborhoods, which are primarily African American, as well as for older youth in high-income locales.

To our knowledge, this is one of the first population-based studies to examine the association between socioeconomic characteristics of neighborhoods across the spectrum of diabetes phenotypes in U.S. youth. Additionally, while most studies examining environmental influences on health use cross-sectional measures of neighborhood context, this study utilized a measure that accounted for 30 years of socioeconomic change in the city of Chicago.

Our study, however, has several limitations. First, cases were ascertained from the medical records of numerous institutions with varying standards for reporting clinical details, allowing possible inconsistencies in assigning phenotype. Second, subgroup analyses by age, ethnicity, and sex using the income diversity index resulted in small cells in some instances, thus increasing the possibility of type II error. Third, the lack of additional individual-level and neighborhood-level covariates may have limited our ability to fully explain variations between neighborhood social environments and youth diabetes risk.

Our study suggests that neighborhood social environment may influence diabetes risk in youth. The hygiene hypothesis proposes, for example, that children residing in impoverished circumstances may have earlier exposure to pathogens that promote immunological maturation, resulting in protection against type 1 diabetes and other autoimmune diseases (13). In contrast, youth residing in affluent neighborhoods may be at lower risk for type 2 diabetes due to better opportunities for behaviors that reduce obesity risk and subsequent insulin resistance (14). The evidence to support these hypotheses, however, remains equivocal.

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References

1. Karvonen M, Viik-Kajander M, Moltchanova E, Libman I, LaPorte R, Tuomilehto J. Incidence of childhood type 1 diabetes worldwide: Diabetes Mondiale (DiaMond) project group. Diabetes Care 2000;23:1516–1526
2. Smith TL, Drum ML, Lipton RB. Incidence of childhood diabetes type 1 and non-type 1 diabetes mellitus in a diverse population: the Chicago Childhood Diabetes Registry, 1994–2003. J Pediatr Endocrinol Metabol 2007;20:1093–1097
3. SEARCH for Diabetes in Youth Study Group. Incidence of diabetes in youth in the United States. JAMA 2007;297:2716–2724
4. Patterson CC, Dahlquist GG, Gyürüs E, Green A, Soltész G, the EURODIAB Study Group. Incidence trends for childhood type 1 diabetes in Europe during 1989–2003 and predicted new cases 2005–20: a multicentre prospective registration study. Lancet 2009;373:2027–2033
5. Fagot-Campagna A, Pettitt DJ, Engelgau MM, Burrows NR, Geiss LS, Valdez R, Beckles GL, Saaddine J, Gregg EW, Williamson DF, Narayan KM. Type 2 diabetes among North American children and adolescents: an epidemiologic review and public health perspective. J Pediatr 2000;136:664–672
6. Lipton RB, Drum M, Li S, Choi H. Social environment and year of birth influence type 1 diabetes risk for African-American and Latino children. Diabetes Care 1999;22:78–85
7. Haynes A, Bulsara MK, Bower C, Codde JP, Jones TW, Davis EA. Independent effects of socioeconomic status and place of residence on the incidence of childhood type 1 diabetes in Western Australia. Pediatr Diabetes 2006;7:94–100
8. Gopinath S, Ortqvist E, Norgren S, Green A, Sanjeevi CB. Variations in incidence of type 1 diabetes in different municipalities of Stockholm. Ann N Y Acad Sci 2008;1150:200–207
9. Rosenbloom AL. Increasing incidence of type 2 diabetes in children and adolescents: treatment considerations. Paediatr Drugs 2002;4:209–221
10. Lipton RB, Drum M, Burnet D, Rich B, Cooper A, Baumann E, Hagopian W. Obesity at the onset of diabetes in an eth-

nically diverse population of children: what does it mean for epidemiologists and clinicians? Pediatrics 2005;115:e553–e560
11. Taylor DG. *Income Diversity and the Context of Community Development*. Chicago, IL, Metro Chicago Information Center, 2007
12. Gary TL, Safford MM, Gerzoff RB, Ettner SL, Karter AJ, Beckles GL, Brown AF. Perception of neighborhood problems, health behaviors, and diabetes outcomes among adults with diabetes in managed care. Diabetes Care 2009;31:273–278
13. Strachan DP, Harkins LS, Johnston ID, Anderson HR. Childhood antecedents of allergic sensitization in young British adults. J Allergy Clin Immunol 1997;99:6–12
14. Kahn SE, Hull RL, Utzschneider KM. Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature 2006;444:840–846