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Neighborhood deprivation and childhood autism: A nationwide study from Sweden

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ABSTRACT

Objective: To examine whether there is an association between neighborhood deprivation and childhood autism, after accounting for family- and individual-level sociodemographic characteristics.
Methods: An open cohort of all children aged 2–11 years was followed between January 1, 2000 and December 31, 2010. Childhood residential locations were geocoded and classified according to neighborhood deprivation (an index of low education, low income, unemployment, and receipt of welfare assistance). Data were analyzed by multilevel logistic regression, with family- and individual-level characteristics at the first level and level of neighborhood deprivation at the second level.
Results: During the study period, among a total of 643,456 children, 1699 (0.3%) were diagnosed with childhood autism. Age-standardized cumulative incidence, defined as first registration for childhood autism during the study period, increased with increasing level of neighborhood deprivation. In the study population, 2.2 per 1000 and 3.6 per 1000 children in the least and most deprived neighborhoods, respectively, were diagnosed with childhood autism. Incidence of childhood autism increased with increasing neighborhood-level deprivation across all family and individual-level sociodemographic categories. The odds ratio (OR) for childhood autism for those living in high-deprivation neighborhoods versus those living in low-deprivation neighborhoods was 1.59 (95% confidence interval = 1.35–1.88). High neighborhood deprivation remained significantly associated with odds of childhood autism after adjustment for family- and individual-level sociodemographic characteristics (OR = 1.28, 95% confidence interval = 1.07–1.53, $P = 0.007$).
Conclusions: This study is the largest so far on potential neighborhood influences on childhood autism. Our results show that neighborhood deprivation is associated with childhood autism, independently of family- and individual-level sociodemographic characteristics.

1. Introduction

Although the specific mechanisms behind childhood autism are largely unknown, risk factors include male sex (Newschaffer et al., 2007), familial history of autism (Newschaffer et al., 2007; Hallmayer et al., 2011), advanced age in either parent at childbirth (Shelton et al., 2010; Parner et al., 2012; Reichenberg et al., 2006), neuropsychiatric disorders (Lichtenstein et al., 2010), perinatal complications (Larsson et al., 2005), ethnic background and migration (Magnusson et al., 2012; Bhasin and Schendel, 2007), and low socioeconomic status (Larsson et al., 2005; Rai et al., 2012; Thomas et al., 2012). In addition to these individual-level factors, it is possible that certain social features of the neighborhood environment are associated with autism. Neighborhood deprivation is a socioeconomic feature of the neighborhood environment that has often been defined based on the proportion of residents with low socioeconomic status, unemployed people and/or people receiving welfare assistance (Cubbin et al., 2006; Lochner et al., 2001; Schempf et al., 2009; Sundquist et al., 1999; Winkleby et al., 2007). High levels of neighborhood deprivation have robustly been shown to be associated with increased risks of a number of health outcomes, including mental disorders (Ivert et al., 2013; Doornbos et al., 2013). Only few studies have, however, examined the association between neighborhood deprivation and autism. For example, one previous study conducted in England found that living in a community with rented social (government-financed) housing is associated with higher prevalence of adult

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autism (Brugha et al., 2011). In addition, the results of previous studies are inconsistent (Thomas et al., 2012; Brugha et al., 2011; Pettygrove et al., 2013; Emerson, 2012; Hock and Ahmedani, 2012). To the best of our knowledge, no previous large-scale study have attempted to ascertain whether neighborhood deprivation is associated with childhood autism, after accounting for family and individual factors.

The present study had the following two aims: 1) to examine the association between neighborhood deprivation and childhood autism, after taking family and individual-level sociodemographic factors into account; and 2) to examine possible cross-level interactions between individual-level sociodemographic factors and neighborhood-level deprivation in order to determine whether neighborhood-level deprivation has a differential potential effect on the risk of childhood autism across subcategories of family- and individual-level factors (effect modification).

2. Methods

Data used in this study were retrieved from a national database, which contains longitudinal information on the entire population of Sweden. The dataset we used contains nationwide information on parents and their offspring at the individual and neighborhood levels, including comprehensive demographic and socioeconomic data. The information in the present dataset comes from several Swedish national registers. The registers used in the present study were the Total Population Register, the Multi-Generation Register, the Hospital Discharge Register, and the Outpatient Register. Individuals (children and their parents) were tracked using their personal identification numbers (assigned to each resident of Sweden), which were replaced with serial numbers to provide anonymity. The follow-up period started on January 1, 2000 and proceeded until hospitalization/outpatient treatment for autism, death, emigration or the end of the study period on December 31, 2010. All residents in Sweden aged 2–11 years, a total of 643,456 children, were followed. During the follow-up period, 10,329 children moved out of the country and 827 children died.

2.1. Outcome variable: childhood autism

The outcome variable in this study was a hospital or outpatient diagnosis of childhood autism (age at diagnosis 2–11 years) during the study period. By age 2, a diagnosis of autism by an experienced professional can be considered very reliable (Lord et al., 2006). Data on inpatient and outpatient diagnoses of autism were retrieved from the Hospital Discharge Register (2000–2010) and Outpatient Register (2001–2010). These registers contain information on all hospitalizations and outpatient visits, including clinical diagnoses. We searched the Hospital Discharge Register and Outpatient Register for the International Classification of Diseases (ICD)-10 codes F84.0, denoting autism as the main diagnosis, during the entire study period. The serial numbers were used to ensure that each individual appeared only once in the dataset, for his or her first hospital diagnosis of autism during the study period. A recent study from Sweden found that 96% of the register-based diagnoses of autism were valid (Idring et al., 2012).

2.2. Neighborhood-level deprivation

All Swedish individuals have been geocoded to small geographic units with boundaries defined by homogeneous types of buildings. These neighborhood areas, called small area market statistics or SAMS, each contain an average of 1000 residents and were created by the Swedish Government-owned statistics bureau Statistics Sweden. SAMS were used as proxies for neighborhoods, as has been done in previous research (Cubbin et al., 2006; Sundquist et al., 2006a). Neighborhood of residence is determined annually using the National Land Survey of Sweden Register.

A summary index was calculated to characterize neighborhood-level deprivation. The neighborhood index was based on information about female and male residents aged 20 to 64 because this age group represents those who are among the most socioeconomically active in the population (i.e., a population group that has a stronger impact on the socioeconomic structure in the neighborhood than children, younger women and men, and retirees do). The neighborhood index was based on four items: low education level (<10 years of formal education), low income (income from all sources, including that from interest and dividends, <50% of the median individual income), unemployment (excluding full-time students, those completing military service, and early retirees), and receipt of social welfare. The index was used to categorize neighborhood deprivation as low (more than one SD below the mean), moderate (within one SD of the mean), and high (more than one SD above the mean) (Winkleby et al., 2007).

2.3. Individual-level sociodemographic variables

Sex of child: male or female.

Age ranged from 2 to 11 years and was divided into three categories: 2–4, 5–8, and 9–11 years.

Maternal *marital status* was categorized as (1) married/cohabitating or (2) never married, widowed, or divorced.

Family income was calculated as annual family income divided by the number of people in the family. The family income parameter took into consideration the ages of the family members and used a weighted system whereby small children were given lower weights than adolescents and adults. The sum of all family members' incomes was multiplied by the individual's consumption weight divided by the family members' total consumption weight. The final variable was calculated as empirical quartiles from the distribution.

Maternal and paternal education level was categorized as completion of compulsory school or less (≤9 years), practical high school or some theoretical high school (10–11 years) and completion of theoretical high school and/or college (≥12 years).

Maternal and paternal country of birth was categorized as Sweden, Western countries (Western Europe, USA, Canada, Oceania), and others.

Maternal *urban/rural status* was classified as living in a large city, a middle-sized town, or a small town/rural area. This variable was included because urban/rural status may be associated with access to preventive antenatal care. Large cities were those with a population of ≥200,000 (Stockholm, Gothenburg and Malmö). Middle-sized towns were towns with a population of ≥90,000 but <200,000. Small towns were towns with a population of ≥27,000 and <90,000; rural areas were those areas with smaller populations than those of small towns. This classification yielded three equally-sized groups.

Mobility: children were classified as having "not moved" or "moved" to another neighborhood with the same or a different level of deprivation within five years.

Maternal age at childbirth and *paternal age at childbirth* was classified as <30, 30–39, and ≥40 years.

Because autism is known to cluster in families (Newschaffer et al., 2007; Hallmayer et al., 2011), children were classified according to whether or not they had a *sibling history of autism*.

Comorbidities: Perinatal complications were defined as a hospitalization (within the first year of birth) for a main diagnosis of a perinatal complication (ICD-10: P00–P99); *Psychiatric disorders* were defined as a hospitalization (within 11 years after birth and in the follow-up period) for a main diagnosis of a psychiatric disorder (ICD-9: 290-319, except for 299.0; and ICD-10: F00–F99, except for F84.0).