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Epilepsy, birth weight and academic school readiness in Canadian children: Data from the national longitudinal study of children and youth

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ABSTRACT

Purpose: Birth weight is an important indicator of prenatal/in-utero environment. Variations in birth weight have been reportedly associated with risks for cognitive problems. The National Longitudinal Survey of Children and Youth (NLSCY) dataset was explored to examine relationships between birth weight, academic school readiness and epilepsy.
Methods: A population based sample of 32,900 children of the NLSCY were analyzed to examine associations between birth weight, and school readiness scores in 4–5-year-old children. Logistic and Linear regression was used to examine associations between having epilepsy and these outcomes. Gestation data was available on 19,867 children, full-term children represented 89.67% (gestation > 259 days), while 10.33% of children were premature (gestation <258 days). There were 20 children with reported epilepsy in the sample. Effects of confounding variables (diabetes in pregnancy, smoking in pregnancy, high blood pressure during pregnancy, and gender of the infant) on birth weight and epilepsy were controlled using a separate structural equation model.
Results: Logistic regression analysis identified an association between epilepsy and lower birth weights, as well as an association between lower birth weight, having epilepsy and lower PPVT-R Scores. Model results show the relationship between low birth weight and epilepsy remains statistically significant even when controlling for the influence of afore mentioned confounding variables.
Conclusion: Low birth weight appears to be associated with both epilepsy and academic school readiness. The data suggest that an abnormal prenatal environment can influence both childhood onset of epilepsy and cognition. Additional studies with larger sample sizes are needed to verify this relationship in detail.

1. Introduction

Prior published studies have validated the National Longitudinal Survey of Children and Youth dataset as a valuable source of information on childhood epilepsy. The authors previously used the NLSCY to determine the prevalence of epilepsy in Canadian children using Cycles 2 and 3 and found our estimates to be comparable to other published studies (Christensen et al., 2007; Kim et al., 2016; Prasad et al., 2011). This finding validates the NLSCY as a good source of data for examining population trends in the cohort of children who experience epilepsy during childhood.

A previous study using NLSCY data provides objective evidence that children with epilepsy are at risk of scholastic underachievement at school entry, while those with additional health impairments as measured by the Health Utilities Index (HUI) score are at an even greater risk of academic underachievement. Risk factors for low birth weight include maternal health, socioeconomic factors, smoking and access to antenatal care that lead to a poor prenatal/in-utero environment (Neel and Alvarez, 1991; Xaverius et al., 2016). Variations in birth weight have been reportedly associated with increased risk for cerebral palsy, intellectual impairments, problems in school outcomes and epilepsy (Shenkin et al., 2004; Stoinska and Gadzinowski, 2011; Sun et al., 2008).

Studies on the relationship between birth weight, gestational age and epilepsy have been inconclusive or report conflicting

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findings in the literature owing to different study methodology, and outcome variables. Rocca et al. reported an association between small for gestational age or low birth weight in individuals with absence and complex partial seizures but not for generalized seizures (Rocca et al., 1987a,b,c). A population based study using the Danish Civil Registration system to identify a cohort of growth restricted singletons, described increasing incidence rates of epilepsy with decreasing gestational age and birth weight. This relationship was noted to be stronger during the early years (Sun et al., 2008). Further, a case control study reported an association between lower mean birth weights and epilepsy (Jackson et al., 2014). In the same study a positive correlation between birth weight and cognition scores was observed in normal children; however, no significant relationship between birth weight and measures of intelligence, language, academic achievement, memory, executive function, or cognitive/psychomotor speed could be established in children with epilepsy.

Using NLSCY survey data, this study examines the relationship between birth weight, gestation, and gender in two groups; children with, and without epilepsy. It compares the performance on the Peabody Picture Vocabulary Test -Revised (PPVT-R) as a measure of their cognitive abilities at school entry between the above-mentioned groups. In addition, the relationship of diabetes, high blood pressure, and smoking during pregnancy to birth weight and epilepsy was also explored. The survey specifically covered these three variables as part of the questionnaire on medical and biological variables that impact the health of the child. The availability of this information in the survey data provided us an opportunity to examine these variables through statistical models.

2. Materials and methods

2.1. Participants & sample selection

The data source was Canada's National Longitudinal Survey of Children and Youth (NLSCY). The survey was developed to track extrinsic socioeconomic and intrinsic family and personal factors influencing child development in Canada. The first cohort of children included a sample size of 22,831 with an age range of birth to 11 years.

This group of children were surveyed subsequently every 2 years for a total of 8 cycles. Cross-sectional samples were used from cycle 1 through 4 cycles (1994/95, 1996/97, 1998/99, and 2000/2001), terminating in 2008–2009.

New samples of children from 0 to 2 years of age were added to each cycle, allowing for cross-sectional studies up to cycle 4, and longitudinal analysis up to cycle 8.

The respondents form a representative sample of children and youth from Canada's ten provinces when sampling or bootstrap weights are applied. For further details on sampling and other methodology employed in the NLSCY the reader is referred to the NLSCY document on survey instruments and previously published papers using the same dataset (NLSCY Project Team, 1996; Prasad et al., 2011, 2014).

2.2. Survey questions & measures

In the survey questionnaire, the PMK was asked specifically "What was his/her birth weight in kilograms and grams/pounds and ounces". The measured birth weight of the child was reported in kilograms (Kg) and treated as a continuous variable. The mean birth weight of the sample was 3.42 kg with a standard deviation of 0.59 kg. The variable birth weight was also centred on the mean so "0" represents a child with an average birth weight for the sample.

Gestation data was measured as a dichotomous variable. Children with a gestational age of 258 days or less were considered premature and coded as "1" based on the response to the question on "whether the child was born on or before or after the due date" and by how many weeks before the due date (HLTQ4C, HLTQ4C1, HLTQ4D1, HLTQ4D2). Children born 259 days or more were coded as "0" which indicates they were not born premature.

Differences in birth weight and PPVT-R scores in 4- and 5-year-old children were examined from pooled data from Cycles 1–5 of the NLSCY, after which the cycles became part of the longitudinal data set and no cases were added. An indicator variable was used to compare the cohorts with and without epilepsy where "1" indicated a child who had been diagnosed with epilepsy and "0" indicated the child had not been diagnosed with epilepsy.

Twenty (20) children were identified as having been diagnosed with epilepsy, while 19,760 children did not report a current diagnosis of epilepsy. There were 32,900 children in the pooled sample from cycles one to five, 11,327 or 34.42% were four year of age and 21,573 or 65.57% were five years of age (Table 1). The sample size of 20 children with epilepsy exceeds referenced guidelines, requiring a minimum of 5 cases per group or in more conservative approaches a minimum of 10 cases per group for each independent variable in the model (Hair et al., 1995).

A total of 13,033 children with missing data were systematically excluded from the regression analysis because they did not have valid data on at least one of the variables in the study. Missing data could also include valid skips in the survey design. The excluded cases are not considered to be problematic because they are missing completely at random with no relationship between the dependent variable and the missing independent variable (Little and Rubin, 2014).

Maternal data included: High BP during pregnancy reported in 4272 (9.54%), Diabetes during Pregnancy in 2391 (5.34%), and smoking during pregnancy in 8006 (17.88%) mothers (Table 1).

The NLSCY dataset represents a useful sample of Canadian children that is beneficial for identifying trends in children with and without epilepsy. The estimates for epilepsy in the sample were close to population and clinically based estimates of the Canadian population; however, this sample was intended for comparative analysis only. Point estimates of prevalence of epilepsy in Canadian children are provided in an earlier paper (Prasad et al., 2011).

The PPVT-R is a test of school readiness evaluating the receptive vocabulary acquisition in 4–5-year-old children. This test was originally developed by Lloyd and Leota Dunn (University of Hawaii)(Dunn and Dunn, 1981); a revised version was used by Statistics Canada in collaboration with the author of the test to shorten the survey burden on the respondents. A French adaptation was created by the test's authors as well as Claudia M. Thériault-Whalen (St. Thomas University, Fredericton; (Canada. Human Resources Development Canada and Statistics Canada, 1995). The test was normalized on a nationally representative sample of children and youth in both the US and Canada. Raw scores, standardized scores (mean 100, standard deviation 15) and percentile scores are provided. PPVT_R scores may have shown up as missing if the individual was unable to take the test for health impairments that were severe enough to prevent participation or other reasons. The PPVT-R was administered at a single time-point in any child's survey; i.e. administered only once per-child at either four to five years of age. Scores were centred on the mean score set to "0" and represents a child with an average PPVT-R score.

3. Results

Several models were run on the data to examine relationships between the presence of epilepsy and measures of low birth weight