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# The socioeconomic gradient in the developmental health of children with disabilities at school-entry: a cross-sectional study



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**The socioeconomic gradient in the developmental health of children with disabilities at school-entry: a cross-sectional study**

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**Abstract**

***Objective:*** To examine the relationship between developmental health and neighborhood SES in kindergarten children with disabilities.

***Design:*** Cross-sectional study using population-level database of children's developmental health at school entry (2002 – 2014).

**Setting:** 12 of 13 Canadian provinces/territories.

***Measures:*** Taxfiler and Census data from 2005 and 2006, respectively, were aggregated according to custom-created neighborhood boundaries and used to create an index of neighborhood-level SES. Developmental health outcomes were measured using the Early Development Instrument (EDI) that evaluates developmental health across five domains and is completed by teachers in the second-half of the kindergarten year for every child in their class based on their observations of the child during the first half of the year.

**Analysis:** Hierarchical generalized linear models were used to test the association between neighborhood-level SES and developmental health.

***Results:*** All EDI domains were positively correlated with the neighborhood-level SES index. The strongest association was observed for the language & cognitive development domain (β (SE): 0.29 (0.02)) and the weakest association was observed for the emotional maturity domain (β (SE): 0.12 (0.01)).

***Conclusions:*** The magnitude of differences observed in EDI scores across neighborhoods at the 5$^{th}$ and 95$^{th}$ percentiles are similar to the effects of more established predictors of development, such as sex. The association of SES with developmental outcomes in this population may present a potential opportunity for policy interventions to improve immediate and longer-term outcomes.

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**Strengths and limitations of this study**

- Our investigation uses a large, representative population-level database, that allowed us to focus on children with disabilities that make up only a small proportion of the population, while also maximizing external validity and statistical power and minimizing potential selection bias.
- We used data from the EDI, a valid and reliable measure of children's developmental health.
- We focused on early childhood, a time that has been well documented to critically impact children's long-term academic and social trajectory.
- We applied a non-categorical approach to childhood disabilities that reflects current thinking in the field of child development.
- The study's limitation is the exclusive use of neighborhood-level socioeconomic status indicators, without the ability to control for family-level ones.

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**Introduction**

To date, associations between a number of health outcomes and a combination of economic, human, and social characteristics, commonly conceptualized as socioeconomic gradients, have been reported, including end-stage renal disease, breast cancer, obesity, and cardiometabolic health.[1-6] These studies have mostly focused on chronic conditions in adulthood, with studies on the socioeconomic determinants of child health emerging only more recently.[7-11]

A socioeconomic gradient in typically developing children's developmental health has been reported in a number of high-, middle-, and low-income countries,[12-14] including Canada.[8 15-17] Additionally, the prevalence of childhood disabilities has been consistently shown to be negatively associated with SES.[18] Stabile & Currie (2003) used data from the Canadian National Longitudinal Survey of Children and Youth (NLSCY) for children between 0 and 11 years of age to illustrate an inverse relationship between the prevalence of chronic childhood disabilities and SES.[19] Msall and colleagues (2007) reported a more than three-fold difference in disability rates between children living in distressed vs. advantaged neighborhoods in Rhode Island.[20] However, little is known about the relationship between SES and developmental outcomes in children with special needs . Existing evidence most often addresses specific diagnoses during middle childhood, is not representative of all disabilities experienced by children during early childhood, and does not consider the impact of SES outside of the immediate family environment (i.e., neighborhood SES) which has been shown to be a significant influence on developmental outcomes in typically developing children.[8 21 22,23] Understanding determinants of developmental health in early childhood can help in identifying groups of children with disabilities that are likely to be most at risk for worse academic and social outcomes later in life. Such identification is useful for policy planning and the provision of health and education services. The objective of this study is to determine if there is a socioeconomic gradient in the developmental health of children with disabilities at school entry. This work extends existing research in that it focuses on

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early childhood, a time at which experiences set the trajectory for future academic and social outcomes, takes a diagnosis-free, non-categorical approach to childhood disability, and uses population-level data.

## Methods

The project was approved by the Hamilton Integrated Research Ethics Board (no. 2403).

### *Patient and Public Involvement*

Patients/the public were not involved in the design or conduct of this study.

### *Data Source and Measurement*

Data for this study come from a Pan-Canadian database on early childhood development.[8 24] The database includes cross-sectional data from all Canadian provincial implementations between 2004 and 2014 of the Early Development Instrument (EDI), a population-level instrument developed by Janus and Offord (2007). The EDI is used to evaluate children's developmental health outcomes during the kindergarten year across five core domains: physical health & wellbeing, social competence, emotional maturity, language & cognitive development, and communication skills & general knowledge.[25] The EDI is completed by teachers in the second half of the kindergarten year (the year before Grade 1) - usually between February and March - based on their observations of each child. It is comprised of 103 core items, and domain scores range from 0 to 10, with higher scores indicating better developmental health. The EDI has been validated extensively for both typically-developing children[25-34] and those with disabilities.[35]

The database also includes data on children's age, sex, and whether they have a "special needs" designation.[24] The "special needs" designation is the operational indicator of childhood disability in our study. Definitions of "special needs" are set by each province/territory,[36 37] but they are similar and generally include children with identified health problems, with or without formal medical diagnoses, that impede their ability to learn in a regular classroom. Children encompassed by this definition have a broad range of impairments, varying widely in both type (e.g., physical or mental) and severity (e.g., mild

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speech impairment to non-verbal). The EDI database has been linked to Canadian Census and Taxfiler data from 2006 and 2005, respectively, using custom-created neighborhood boundaries. Meaningful boundaries were delineated using information on existing social structures and administrative and geographic divisions.[38] Census and Taxfiler variables were used to create the Canadian Neighbourhoods and Early Child Development (CanNECD) SES index, which includes indicators of education, language/immigration, marital status, wealth, income, dues, social capital, poverty, residential stability, and income inequality (Table S1).[39]

***Analysis***

All data analyses were conducted in SAS™ software using the GLIMMIX procedure.[40] Given that EDI domain scores are left-skewed and restricted in range, and that children are clustered within neighborhoods and schools, EDI data were transformed from left- to right-skewed by subtraction from 11, and analyzed using hierarchical generalized linear modeling (HGLM) with the identity link and gamma distribution. The fit of other distributions and link functions was also assessed but found to be generally inferior. Although children are clustered within two levels (neighborhoods and schools), only neighborhood of residence was included as a cluster variable due to data sparseness.[41] All models were performed using the Laplace approximation that allows estimation of likelihood statistics and has been shown to perform well with regard to accuracy and precision.[42]

EDI domain scores were used as the dependent variable. For each EDI domain, the analysis was performed hierarchically in three steps. First, an intercept-only model was constructed. Second, a model with child-level characteristics that have been found to be significant predictors of children's developmental health (i.e., age, sex, and English/French language learner status (EFSL)) as fixed-effects was constructed.[25 43] Additionally, dummy variables for year of data collection, province, and the interaction between the two were included to control for variations in data collection procedures across time points and provinces. Finally, to evaluate the association between neighborhood-level SES and

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children's developmental health, the SES index was added in the third model. Random effects of each of the individual predictors were added to the final model one-by-one and the overall improvement in the fit of the model was tested.

To assess whether the inclusion of child-level characteristics (age, sex, EFSL status), neighborhood-level SES, and random effects significantly improved model fit, partial likelihood ratio tests were performed, and goodness-of-fit indices (i.e., Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC)) were compared between models. Multicollinearity was tested by examining variance inflation factor (VIF) statistics for age, sex, EFSL status, and the SES index. VIF statistics for province of residence, time of data collection, and their interaction are not included as these were artificially inflated due to having been dummy coded and included as part of a regression model with few predictors. Leverage statistics, along with plots of raw, Pearson, and studentized residuals were used to identify outliers and influential observations. Observations with leverage statistics more than twice the mean of all leverage values were investigated for data entry error. A sensitivity analysis was conducted where observations with outlying studentized residuals, defined as studentized residuals with absolute values greater than two, were excluded in the estimation of the models. Cases with missing data were excluded from the analysis but were compared to those without missing data to ensure no substantial differences in demographic characteristics.

## Results

### *Population Characteristics*

A total of 29,520 children with disabilities were identified in the database. Population characteristics are presented in Table 1.

These children resided in 2,016 neighborhoods. Neighborhood characteristics are presented in Table 2. Forty (1.95%) neighborhoods in the database were excluded from the analysis due to not having

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any children with special needs (Table S2). These neighborhoods included fewer children overall, were of higher SES, and did not proportionally represent Canadian provinces as the majority were in Quebec.

Characteristics of children missing any one of the five EDI domain scores are presented in Table S3. Overall, only a small proportion of children (<2%) were missing data on any of the EDI domains and these children did not differ in demographic characteristics from the analytic sample.

***Model Results***

Regression coefficients, their levels of significance, and goodness-of-fit indices from the final model for each of the EDI domains are presented in Table 3. Additional details on each step of model development along with goodness-of-fit indices are presented in supplementary tables 4 through 8. The gamma distribution with an identity link produced the best fit for most domains, as assessed by AIC and BIC statistics (Table S9). Random effects of predictors did not significantly improve fit and so they were not included in the final model.

The results of the regression analysis indicate that both child-level characteristics and SES are significant predictors of children's EDI domain scores, as indicated by decreasing deviance, AIC, and BIC statistics across models, as well as significant likelihood ratio tests (supplementary tables 4 through 8).

Year of data collection, province/territory, and the interaction between them were statistically significant for all domains. Age was statistically significant for all domains except physical health & wellbeing. Age was positively associated with language and cognitive development scores, and negatively with emotional maturity, social competence, and communication skills & general knowledge, with the largest effect sizes seen in the latter two domains and the smallest in physical health & wellbeing. Sex was statistically significant for all EDI domains and, on average, girls had higher scores than boys on all domains of the EDI, with the smallest sex differences in language & cognitive development, and largest in emotional maturity. English/French language learners had higher scores than non-learners in emotional maturity (smallest absolute effect) but lower scores in language &

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cognitive development and communication skills & general knowledge (largest absolute effect). The SES index was a statistically significant predictor of all EDI domains and was consistently positively associated with all domain scores. The smallest association was observed for the emotional maturity scores, and the largest for and language & cognitive development.

***Model Diagnostics and Sensitivity Analyses***

Excluding dummy coded categorical variables, all VIF statistics were below the cut-off of 10 and ranged from 1.05 and 1.10. Studentized residuals were used to identify influential and outlying observations. The results of the sensitivity analysis excluding cases with absolute studentized residual values greater than 2 are presented in Table S10 through 14. The results from this sensitivity analysis were very similar to the results of the primary analysis.

**Discussion**

The objective of this investigation was to examine the association between neighborhood-level SES and developmental health in children with disabilities (operationally defined as "special needs" designation) at school entry, in order to determine the importance of contextual factors in predicting outcomes in this population. The results indicate that neighborhood-level SES is a consistent and significant predictor of developmental outcomes in this population. An average difference of 0.12 to 0.29 points in EDI domain scores was observed per standard deviation difference in SES, with higher EDI domain scores being observed in higher SES neighborhoods. Neighborhood-level SES had the strongest association with the language & cognitive development domain and the weakest with emotional maturity domain.

***Consistency with previous studies***

Comparing the magnitude of association between SES and developmental health with previous literature is difficult due to differences in the operationalization of these constructs and differences in analytic methods. Previous studies, mostly conducted with typically developing children,[12] have either explored the direct association between SES and developmental health[8 15-17 44] or investigated mediators



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of this relationship, including parent/child activities, access to a computer, participation in organized classes and activities, and maternal mental health.[45-47] Most of these studies measured SES at the individual family level and all demonstrated a positive association between social and economic variables and developmental health.

Among the studies done in typically developing populations, four use EDI outcomes, with three including neighborhood-level measures of SES.[8 15 17] All studies demonstrated a positive association between SES and the EDI. The most recent study looked at neighborhood effects in typically developing children using four published neighborhood SES indices.[8] The strength of association between the indices and EDI domains varied, depending on the SES index used. Similar to our results, the strongest association was most often found for the language & cognitive development domain.

The few studies done in children with disabilities also report a positive association between SES and academic and social outcomes.[21-23 48-50] These studies are different from the present investigation in that they only focus on a few high-incidence diagnoses, such as learning disabilities during middle childhood and adolescence and do not measure SES at the neighborhood-level.

***Strengths and limitations***

There are several strengths of this study. First, we used population-level data, which made focusing on children with disabilities that only make up a small proportion of the population possible, while also maximizing external validity and statistical power and minimizing potential selection bias. Second, we focused on early childhood, a time that critically impacts children's long-term academic and social trajectory.[51] Third, we applied a non-categorical approach to childhood disabilities which reflects current thinking in the field of child development and findings that diagnostic categories often do not fully reflect the actual abilities and needs of children.[52-54] Fourth, the EDI has undergone extensive reliability and validity testing, and has been found to be predictive of academic achievement and social functioning throughout early and middle childhood.[25-34] The psychometric performance of the EDI in



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children with special needs has also been found similar to its performance in typically developing children.[35] Currently, the EDI is the only available indicator of developmental health that allows examination of variability across Canada at a population-level. Finally, the analytic methods used in this investigation appropriately take into account the skewed distribution and nesting of EDI data, which prevents artificially deflated standard errors and hence inappropriate statistically significant findings.

This investigation is also subject to limitations. First, due to the cross-sectional design of this study, causality cannot be established. There is evidence that developmental problems in children may increase parental stress and impact the general socioeconomic wellbeing of families.[55 56] Additionally, there is the possibility of self-selection where families with similar experiences may choose to reside within similar neighborhoods. Regardless of causality, or lack thereof, the results of this study indicate that services aimed at young children with disabilities that are particularly accessible in low SES neighborhoods are likely to be most impactful.

Second, we used a very broad definition of disability, which is based on the designation of the child by the education system at kindergarten, and hence, children with disabilities who did not have this designation by the education system were excluded. It is possible that a very small minority of children who were not typically developing but did not have this designation were excluded.

Third, the SES index may not accurately reflect the socioeconomic condition of the neighborhoods in which children were raised. The variables used to construct the SES index come from 2005 and 2006, whereas EDI data were collected between 2004 and 2014. It is possible that changes in neighborhoods or relocation of families could render the SES index less reflective of the true early environment for some groups of children, which may have led to underestimation of the association between SES and developmental outcomes. However, empirical evidence indicates that it is unlikely for neighborhood characteristics to drastically change over time or for families move to neighborhoods which are greatly different from their previous ones.[57]

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Finally, we were unable to control for family-level SES in the models. Thus, it is not possible to determine whether this association is driven by neighborhood or family characteristics. We were also unable to control for specific diagnoses or severity of disabilities that have undoubted impact on child development. Similar investigation should be extended for smaller subgroups of children who share diagnoses or functional impairments.

***Implications***

Our findings indicate that the relationship between SES and developmental outcomes also holds for children with disabilities.[8 15-17 44 58] This underscores the potential impact of the early environment of children on their development. Although clinicians often focus on biological factors, such as family history of disabilities and harmful exposures in utero, social influences have commonly been found to be more predictive of long-term developmental and academic outcomes and may be more amenable to change.[44] According to survey data, clinicians are receptive to screening for social determinants of health outside of the purview of clinical care, suggesting that the findings of this investigation are likely to be relevant and acceptable to those in the clinical community.[59]

Our findings show that the association between child development and socioeconomic status, which is well-established for typically developing children, also exists for children with disabilities. This highlights the urgency for improving the social and economic context in which children are raised, in addition to targeted interventions delivered at the individual child level. Failure to do so will likely result in further perpetuation of inequities in child development – more so as children with disabilities are already among the most disadvantaged groups globally.[18 60] It remains to be seen whether large-scale policy interventions can help in reducing disparities in this population similarly to other groups.[61]

Additional investigations could further strengthen and contextualize these findings. Specifically, establishing the consistency and relative strength of the relationship between SES and developmental outcomes across subgroups of physical, behavioral, and learning disabilities, as well as subgroups based



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on severity of condition and time of diagnosis, would further untangle the relationship between SES, disabilities, and development, and would be helpful in identifying service provision strategies that are likely to be most successful in improving outcomes.

**Conclusion**

The results from this investigation show neighborhood SES to be significantly associated with the developmental health of children with disabilities at school entry. These findings have implications for policy planning and provision of health and educational service and draw attention to the universality of importance of contextual factors for development of all children.

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**Competing interests:** None.

**Contributions:** DZ, ED, TB, MJ, MG, BF, and MB conceived the study. DZ analyzed and ED provided technical expertise. DZ wrote the first draft of the manuscript and all authors made significant contributions to the manuscript.

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**Table 1: Population characteristics**

| **Sex** | **N (% of population of children with disabilities)** |
|---|---|
| Female | 8906 (30.2) |
| Male | 20585 (69.7) |
| Missing | 29 (0.1) |
| **Age** | |
| Mean (SD) | 5.79 (0.41) |
| Missing | 114 (0.39) |
| **EFSL Status** | **N (%)** |
| Yes | 3637 (12.3) |
| No | 25402 (86.0) |
| Missing | 481 (1.6) |
| **Province** | **N (%)** |
| Alberta | 2099 (7.1) |
| British Columbia | 5044 (17.1) |
| Manitoba | 2468 (8.4) |
| New Brunswick | 327 (1.1) |
| Newfoundland | 641 (2.2) |
| Nova Scotia | 1083 (3.7) |
| Northwest Territories | 65 (0.2) |
| Ontario | 13198 (44.7) |
| Prince Edward Island | 29 (0.1) |
| Quebec | 3023 (10.2) |
| Saskatchewan | 1440 (4.9) |
| Yukon | 103 (0.3) |
| **Year of data collection** | **N (%)** |
| 2004 | 474 (1.6) |
| 2005 | 2332 (7.9) |
| 2006 | 4304 (14.6) |
| 2007 | 1471 (5.0) |
| 2008 | 1762 (6.0) |
| 2009 | 4786 (16.2) |
| 2010 | 2658 (9.0) |
| 2011 | 3494 (11.8) |
| 2012 | 5140 (17.4) |
| 2013 | 2711 (9.2) |
| 2014 | 388 (1.3) |
| **Mean (SD) EDI domain scores** | |
| PHWB | 7.02 (2.12) |
| SC | 5.71 (2.63) |
| EM | 6.13 (1.99) |
| LCD | 6.18 (3.01) |
| CSGK | 4.37 (3.27) |

PHWB=Physical health & wellbeing; EM=Emotional maturity; LCD=Language & cognitive development; CSGK=communication skills & general knowledge

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**Table 2: Neighborhood characteristics (N=2016)**

| **Province** | **Number of neighborhoods (%)** |
|---|---|
| Alberta | 259 (12.8) |
| British Columbia | 298 (14.7) |
| Manitoba | 75 (3.7) |
| New Brunswick | 48 (2.4) |
| Newfoundland | 41 (2.0) |
| Nova Scotia | 57 (2.8) |
| Northwest Territories | 3 (0.1) |
| Ontario | 795 (39.4) |
| Prince Edward Island | 6 (0.3) |
| Quebec | 373 (18.5) |
| Saskatchewan | 55 (2.7) |
| Yukon | 6 (0.3) |
| **Median (IQR) number of children with disabilities in each neighbourhood** | 11 (6 – 19) |
| **Median (IQR) number of children in each neighborhood** | 128 (87 – 194) |

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**Table 3: Final Hierarchical Generalized Linear Models (HGLMs) for the Early Development Instrument (EDI)**

| Variables | Physical health & wellbeing (PHWB) | Social competence (SC) | Emotional maturity (EM) | Language & cognitive development (LCD) | Communication skills & general knowledge (CSGK) |
|---|---|---|---|---|---|
| | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) |
| **Age** | -0.04 (-0.01 to 0.03) | -0.13 (-0.22 to -0.05) | -0.08 (-0.14 to -0.02) | 0.10 (0.01 to 0.18) | -0.13 (-0.24 to -0.02) |
| **Sex (M=0; F=1)** | 0.14 (0.08 to 0.19) | 0.76 (0.69 to 0.83) | 0.81 (0.76 to 0.86) | 0.13 (0.05 to 0.21) | 0.43 (0.33 to 0.53) |
| **EFSL (no=0; yes=1)** | 0.04 (-0.04 to 0.12) | -0.10 (-0.20 to 0.01) | 0.12 (0.05 to 0.20) | -0.43 (-0.56 to -0.31) | -1.11 (-0.94 to -1.27) |
| **SES z-score** | 0.17 (0.14 to 0.20) | 0.17 (0.13 to 0.21) | 0.12 (0.09 to 0.15) | 0.29 (0.24 to 0.33) | 0.19 (0.14 to 0.24) |

95% CIs=95% confidence intervals; EFSL=English/French as a second language; SES=socioeconomic status

Note that coefficient presented in this table reflect the directionality of the association between variables and untransformed EDI scores.

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**Table S1: Variables included in the Canadian Neighbourhoods and Early Child Development (CanNECD) socioeconomic status (SES) index**

| | |
|---|---|
| **Education** | % with no high school diploma |
| **Language/Immigration** | % not speaking either official language at home |
| **Marital Status** | % separated or divorced |
| **Wealth** | % with investment income, families with children under 6 |
| **High Income** | % with incomes ≥ twice than provincial median, families with children under 6 |
| **Dues** | % with union/association dues, families with children under 6 |
| **Social Capital** | % with charitable donations, families with children under 6 |
| **Poverty** | % with low income, lone parent families with children under 6 |
| **Residential Stability** | % non-migrant movers in the past year |
| **Income Inequality** | Gini Coefficient, lone female families with children under 6 |

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**Table S2: Descriptive characteristics of neighborhoods excluded from analysis (n=40)**

| Province | Number of neighborhoods (%) |
|---|---|
| **Alberta** | 8 (20) |
| **New Brunswick** | 4 (10) |
| **Ontario** | 5 (12.5) |
| **Quebec** | 23 (57.5) |
| **Median (IQR) number of children in each neighbourhood** | 83 (56-141) |
| **Mean (SD) of standardized SES index** | 0.38 (0.88) |

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**Table S3: Descriptive characteristics of population of children with missing Physical Health & Wellbeing (PHWB) scores (n=446)**

| | PHWB | SC | EM | LCD | CSGK |
|---|---|---|---|---|---|
| **Sex** | **N (%)** | | | | |
| Female | 123 (27.6) | 138 (30.5) | 166 (27.7) | 154 (28.4) | 128 (30.4) |
| Male | 318 (71.3) | 311 (68.7) | 429 (71.5) | 384 (70.8) | 289 (68.6) |
| Missing | 5 (1.1) | 4 (0.9) | 5 (0.8) | 4 (0.7) | 4 (1.0) |
| **Age** | | | | | |
| Mean (SD) | 5.78 (0.40) | 5.73 (0.4) | 5.78 (0.4) | 5.76 (0.4) | 5.76 (0.41) |
| Missing | 7 (1.57) | 6 (1.3) | 8 (1.3) | 6 (1.1) | 7 (1.66) |
| **EFSL Status** | **N (%)** | | | | |
| Yes | 61 (13.7) | 61 (13.5) | 76 (12.7) | 77 (14.2) | 59 (14.0) |
| No | 379 (85.0) | 386 (85.2) | 511 (85.2) | 457 (84.3) | 355 (84.3) |
| Missing | 6 (1.3) | 6 (1.3) | 13 (2.2) | 8 (1.5) | 7 (1.7) |
| **Province** | **N (%)** | | | | |
| Alberta | 82 (18.4) | 84 (18.5) | 92 (15.3) | 91 (16.8) | 85 (20.2) |
| British Columbia | 9 (2.0) | 17 (3.8) | 41 (6.8) | 45 (8.3) | 7 (1.7) |
| Manitoba | 122 (27.4) | 117 (25.8) | 131 (21.8) | 121 (22.3) | 113 (26.8) |
| New Brunswick | 1 (0.2) | 1 (0.2) | 4 (0.7) | 1 (0.2) | 0 (0) |
| Newfoundland | 3 (0.7) | 6 (1.3) | 6 (1.0) | 3 (0.6) | 5 (1.2) |
| Nova Scotia | 15 (3.4) | 14 (3.1) | 20 (3.3) | 21 (3.9) | 15 (3.6) |
| Northwest Territories | 1 (0.2) | 1 (0.2) | 2 (0.3) | 1 (0.2) | 1 (0.2) |
| Ontario | 193 (43.3) | 192 (42.4) | 241 (40.2) | 222 (41.0) | 173 (41.1) |
| Prince Edward Island | 0 (0) | 0 (0) | 0 (0) | 1 (0.2) | 0 (0) |
| Quebec | 5 (1.1) | 3 (0.7) | 33 (5.5) | 15 (2.8) | 7 (1.7) |
| Saskatchewan | 8 (1.8) | 13 (2.9) | 19 (3.2) | 14 (2.6) | 10 (2.4) |
| Yukon | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| **Year of data collection** | **N (%)** | | | | |
| 2004 | 3 (0.7) | 3 (0.7) | 7 (1.2) | 3 (0.6) | 2 (0.5) |
| 2005 | 19 (4.3) | 17 (3.8) | 29 (4.8) | 21 (3.9) | 12 (2.9) |
| 2006 | 46 (10.3) | 44 (9.7) | 77 (12.8) | 61 (11.3) | 46 (10.9) |
| 2007 | 26 (5.8) | 23 (5.1) | 39 (6.5) | 32 (5.9) | 21 (5.0) |
| 2008 | 33 (7.4) | 34 (7.5) | 43 (7.2) | 39 (7.2) | 32 (7.6) |
| 2009 | 50 (11.2) | 55 (12.1) | 70 (11.7) | 69 (12.7) | 43 (10.2) |
| 2010 | 51 (11.4) | 48 (10.6) | 57 (9.5) | 58 (10.7) | 43 (10.2) |
| 2011 | 96 (21.5) | 96 (21.2) | 113 (18.8) | 113 (20.8) | 97 (23.0) |
| 2012 | 51 (11.4) | 56 (12.4) | 80 (13.3) | 67 (12.4) | 53 (12.6) |
| 2013 | 71 (15.9) | 74 (16.3) | 84 (14.0) | 79 (14.6) | 72 (17.1) |
| 2014 | 0 (0) | 3 (0.7) | 1 (0.2) | 0 (0) | 0 (0) |
| **Mean (SD) EDI domain scores** | | | | | |
| PHWB | NA | 5.06 (2.17) | 6.70 (2.33) | 6.82 (2.09) | 7.71 (1.96) |
| SC | 5.42 (2.97) | NA | 5.47 (2.54) | 4.78 (2.33) | 5.97 (2.98) |
| EM | 5.90 (2.53) | 5.42 (1.44) | NA | 5.65 (1.89) | 6.31 (1.36) |
| LCD | 5.39 (3.31) | 1.98 (2.38) | 5.51 (3.15) | NA | 6.29 (3.46) |
| CSGK | 3.80 (3.34) | 0.86 (1.91) | 3.77 (3.06) | 2.93 (2.74) | NA |

PHWB=Physical health & wellbeing; SC=Social competence; EM=Emotional maturity; LCD=Language & cognitive development; CSGK=communication skills & general knowledge

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**Table S4: Hierarchical Generalized Linear Model (HGLM) for the Physical Health & Wellbeing (PHWB) main of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | DF | P-value | B coefficient (SE) | F-statistic | DF | P-value | B coefficient (SE) | F-statistic | DF | P-value |
| **Intercept** | 3.98 (0.02) | 47093.34 | 1, 2013 | <0.0001 | 4.75 (1.07) | 19.80 | 1, 2002 | <0.0001 | 4.65 (1.07) | 19.10 | 1, 2002 | <0.0001 |
| **Year (categorical)** | | | | | | 3.95 | 10, 26117 | <0.0001 | | 4.18 | 10, 26116 | <0.0001 |
| **Province (categorical)** | | | | | | 13.94 | 11, 26117 | <0.0001 | | 13.54 | 11, 26116 | <0.0001 |
| **Year*Province** | | | | | | 2.54 | 53, 26117 | <0.0001 | | 2.91 | 53, 26116 | <0.0001 |
| **Age** | | | | | 0.03 (0.03) | 1.04 | 1, 26117 | 0.3089 | 0.04 (0.03) | 1.29 | 1, 26116 | 0.2558 |
| **Sex (M=0; F=1)** | | | | | -0.13 (0.03) | 22.96 | 1, 26117 | <0.0001 | -0.14 (0.03) | 24.11 | 1, 26116 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | -0.02 (0.04) | 0.19 | 1, 26117 | 0.6638 | -0.04 (0.04) | 0.94 | 1, 26116 | 0.3325 |
| **SES z-score** | | | | | | | | | -0.17 (0.02) | 116.76 | 1, 26116 | <0.0001 |
| **Deviance** | 118982.4 | | | | 118334.9 | | | | 118222.1 | | | |
| **AIC** | 118988.4 | | | | 118494.9 | | | | 118384.1 | | | |
| **BIC** | 119005.2 | | | | 118943.5 | | | | 118838.4 | | | |
| **Pearson Chi-Square** | 7394.78 | | | | 7475.81 | | | | 7495.20 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S5: Hierarchical Generalized Linear Model (HGLM) for the Social Competence (SC) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 5.31 (0.02) | 62975.90 | 1, 2014 | <0.0001 | 4.62 (1.26) | 13.47 | 1, 2004 | 0.0003 | 4.46 (1.25) | 12.67 | 1, 2003 | 0.0004 |
| **Year (categorical)** | | | | | | 2.83 | 10, 26106 | 0.0016 | | 2.56 | 10, 26106 | 0.0043 |
| **Province (categorical)** | | | | | | 10.27 | 11, 26106 | <0.0001 | | 10.25 | 11, 26106 | <0.0001 |
| **Year*Province** | | | | | | 2.76 | 53, 26106 | <0.0001 | | 2.76 | 53, 26106 | <0.0001 |
| **Age** | | | | | 0.13 (0.04) | 8.99 | 1, 26106 | 0.0027 | 0.13 (0.04) | 10.12 | 1, 26106 | 0.0015 |
| **Sex (M=0; F=1)** | | | | | -0.75 (0.04) | 439.63 | 1, 26106 | <0.0001 | -0.76 (0.04) | 447.29 | 1, 26106 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | 0.12 (0.06) | 4.82 | 1, 26106 | 0.0284 | 0.10 (0.05) | 3.07 | 1, 26106 | 0.0798 |
| **SES z-score** | | | | | | | | | -0.17 (0.02) | 69.10 | 1, 26106 | <0.0001 |
| **Deviance** | 134806.2 | | | | 134020.8 | | | | 133955.4 | | | |
| **AIC** | 134812.2 | | | | 134180.8 | | | | 134117.4 | | | |
| **BIC** | 134829.0 | | | | 134629.5 | | | | 134571.7 | | | |
| **Pearson Chi-Square** | 6654.52 | | | | 6723.87 | | | | 6736.70 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S6: Hierarchical Generalized Linear Model (HGLM) for the Emotional Maturity (EM) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 4.88 (0.02) | 47093.34 | 1, 2014 | <0.0001 | 4.28 (0.96) | 19.71 | 1, 2003 | <0.0001 | 4.18 (0.95) | 19.00 | 1, 2003 | <0.0001 |
| **Year (categorical)** | | | | | | 2.68 | 10, 25974 | 0.0029 | | 2.42 | 10, 25793 | <0.0001 |
| **Province (categorical)** | | | | | | 9.22 | 11, 25974 | <0.0001 | | 9.04 | 11, 25793 | <0.0001 |
| **Year*Province** | | | | | | 2.12 | 53, 25974 | <0.0001 | | 2.06 | 53, 25793 | <0.0001 |
| **Age** | | | | | 0.08 (0.03) | 6.17 | 1, 25974 | 0.0130 | 0.08 (0.03) | 6.63 | 1, 25793 | 0.0101 |
| **Sex (M=0; F=1)** | | | | | -0.81 (0.03) | 970.94 | 1, 25974 | <0.0001 | -0.81 (0.03) | 969.06 | 1, 25793 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | -0.11 (0.04) | 7.29 | 1, 25974 | 0.0070 | -0.12 (0.04) | 10.01 | 1, 25793 | 0.0016 |
| **SES z-score** | | | | | | | | | -0.12 (0.01) | 65.82 | 1, 25793 | <0.0001 |
| **Deviance** | 119448.7 | | | | 118202.7 | | | | 118136.1 | | | |
| **AIC** | 119454.7 | | | | 118362.7 | | | | 118298.1 | | | |
| **BIC** | 119471.6 | | | | 118811.3 | | | | 118752.3 | | | |
| **Pearson Chi-Square** | 4465.48 | | | | 4421.32 | | | | 4428.30 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S7: Hierarchical Generalized Linear Model (HGLM) for the Language & Cognitive Development (LCD) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 4.82 (0.02) | 37229.70 | 1, 2014 | <0.0001 | 4.36 (1.33) | 10.69 | 1, 2003 | 0.0011 | 4.17 (1.33) | 9.80 | 1, 2003 | 0.0017 |
| **Year (categorical)** | | | | | | 3.78 | 10, 26022 | 0.0029 | | 3.49 | 10, 26021 | <0.0001 |
| **Province (categorical)** | | | | | | 6.32 | 11, 26022 | <0.0001 | | 7.01 | 11, 26021 | <0.0001 |
| **Year*Province** | | | | | | 2.13 | 53, 26022 | <0.0001 | | 2.28 | 53, 26021 | <0.0001 |
| **Age** | | | | | -0.11 (0.04) | 6.34 | 1, 26022 | 0.0118 | -0.10 (0.04) | 5.01 | 1, 26021 | 0.0252 |
| **Sex (M=0; F=1)** | | | | | -0.13 (0.04) | 10.35 | 1, 26022 | 0.0013 | -0.13 (0.04) | 10.42 | 1, 26021 | 0.0013 |
| **EFSL (no=0; yes=1)** | | | | | 0.48 (0.06) | 58.32 | 1, 26022 | <0.0001 | 0.43 (0.06) | 47.13 | 1, 26021 | <0.0001 |
| **SES z-score** | | | | | | | | | -0.29 (0.02) | 160.80 | 1, 26021 | <0.0001 |
| **Deviance** | 135595.0 | | | | 135045.0 | | | | 134891.0 | | | |
| **AIC** | 135601.0 | | | | 135205.0 | | | | 135053.0 | | | |
| **BIC** | 135617.8 | | | | 135653.7 | | | | 135507.3 | | | |
| **Pearson Chi-Square** | 10372.47 | | | | 10458.52 | | | | 10531.822 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S8: Hierarchical Generalized Linear Model (HGLM) for the Communication Skills & General Knowledge (CSGK) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 6.65 (0.03) | 63312.62 | 1, 2014 | <0.0001 | 6.11 (1.78) | 11.76 | 1, 2003 | 0.0006 | 4.65 (1.07) | 19.10 | 1, 2002 | 0.0007 |
| **Year (categorical)** | | | | | | 3.95 | 10, 26141 | 0.0247 | | 1.74 | 10, 26140 | 0.0657 |
| **Province (categorical)** | | | | | | 13.94 | 11, 26141 | <0.0001 | | 5.94 | 11, 26140 | <0.0001 |
| **Year*Province** | | | | | | 2.54 | 53, 26141 | 0.0109 | | 1.51 | 53, 26140 | 0.0094 |
| **Age** | | | | | 0.13 (0.06) | 2.05 | 1, 26141 | 0.0258 | 0.13 (0.05) | 5.19 | 1, 26140 | 0.0227 |
| **Sex (M=0; F=1)** | | | | | -0.42 (0.05) | 7.24 | 1, 26141 | <0.0001 | -0.43 (0.05) | 70.12 | 1, 26140 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | 1.15 (0.08) | 1.50 | 1, 26141 | <0.0001 | 1.11 (0.08) | 173.86 | 1, 26140 | <0.0001 |
| **SES z-score** | | | | | | | | | -0.19 (0.02) | 55.05 | 1, 26140 | <0.0001 |
| **Deviance** | 151991.9 | | | | 151438.8 | | | | 151384.1 | | | |
| **AIC** | 151997.9 | | | | 151598.8 | | | | 151544.1 | | | |
| **BIC** | 152014.7 | | | | 152047.5 | | | | 151992.8 | | | |
| **Pearson Chi-Square** | 6272.57 | | | | 6810.50 | | | | 6817.77 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S9: Goodness-of-fit of different distributions and link functions for the social competence domain**

| | | Identity link | | | Log link | | |
|---|---|---|---|---|---|---|---|
| **Domain** | **Goodness-of-fit statistics** | **Exponential** | **Gamma** | **Normal** | **Exponential** | **Gamma** | **Normal** |
| **Physical health & wellbeing (PHWB)** | AIC | 134241.6 | 118384.1 | 121141.6 | 134240.4 | 118399.9 | 121147.4 |
| | BIC | 134684.7 | 118838.4 | 121595.8 | 134683.5 | 118854.2 | 121601.6 |
| **Social competence (SC)** | AIC | 150247.6 | 113417.4 | 133234.4 | 150247.5 | 134128.9 | NC |
| | BIC | 150690.7 | 134571.7 | 133688.7 | 150690.6 | 134583.2 | NC |
| **Emotional maturity (EM)** | AIC | 144859.5 | 118298.1 | 116476.9 | 144859.8 | 118310 | NC |
| | BIC | 145302.6 | 118752.3 | 116931.2 | 145302.8 | 118764.3 | NC |
| **Language & cognitive development (LCD)** | AIC | 144457.3 | 135053.0 | 140742 | 144457.1 | 135069.7 | 140754.4 |
| | BIC | 144900.3 | 135507.3 | 141196.3 | 144900.2 | 135524 | 141208.7 |
| **Communication skills & general knowledge (CSGK)** | AIC | 163276.5 | 151544.1 | 146002.4 | 163274.7 | 151539.4 | NC |
| | BIC | 163719.5 | 151992.8 | 146456.7 | 163717.8 | 151988.1 | NC |

AIC=Akaike information criterion; BIC=Bayesian information criterion; NC=not converged

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**Table S10: Hierarchical Generalized Linear Model (HGLM) for the Physical Health & Wellbeing (PHWB) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 687 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 4.70 (1.03) | 20.70 | 1, 1999 | <0.0001 |
| **Year (categorical)** | | 6.03 | 10, 25432 | <0.0001 |
| **Province (categorical)** | | 19.14 | 11, 25432 | <0.0001 |
| **Year*Province** | | 4.14 | 53, 25432 | <0.0001 |
| **Age** | 0.02 (0.03) | 0.63 | 1, 25432 | 0.4265 |
| **Sex (M=0; F=1)** | -0.21 (0.03) | 60.10 | 1, 25432 | <0.0001 |
| **EFSL (no=0; yes=1)** | -0.09 (0.04) | 5.07 | 1, 25432 | 0.0243 |
| **SES z-score** | -0.19 (0.02) | 4.14 | 1, 25432 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S11: Hierarchical Generalized Linear Model (HGLM) for the Social Competence (SC) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 317 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 4.54 (1.24) | 13.47 | 1, 2002 | 0.0003 |
| **Year (categorical)** | | 5.26 | 10, 25790 | <0.0001 |
| **Province (categorical)** | | 14.83 | 11, 25790 | <0.0001 |
| **Year*Province** | | 4.43 | 53, 25790 | <0.0001 |
| **Age** | 0.13 (0.04) | 9.48 | 1, 25790 | 0.0021 |
| **Sex (M=0; F=1)** | -0.94 (0.03) | 736.81 | 1, 25790 | <0.0001 |
| **EFSL (no=0; yes=1)** | 0.07 (0.05) | 1.74 | 1, 25790 | 0.1862 |
| **SES z-score** | -0.18 (0.02) | 86.23 | 1, 25790 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S12: Hierarchical Generalized Linear Model (HGLM) for the Emotional Maturity (EM) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 409 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 3.36 (0.91) | 13.54 | 1, 2001 | 0.0002 |
| **Year (categorical)** | | 3.84 | 10, 25566 | <0.0001 |
| **Province (categorical)** | | 12.32 | 11, 25566 | <0.0001 |
| **Year*Province** | | 3.04 | 53, 25566 | <0.0001 |
| **Age** | 0.10 (0.03) | 10.68 | 1, 25566 | 0.0011 |
| **Sex (M=0; F=1)** | -0.91 (0.03) | 1307.36 | 1, 25566 | <0.0001 |
| **EFSL (no=0; yes=1)** | -0.13 (0.04) | 11.97 | 1, 25566 | 0.0005 |
| **SES z-score** | -0.14 (0.01) | 88.74 | 1, 25566 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S13: Hierarchical Generalized Linear Model (HGLM) for the Language & Cognitive Development (LCD) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 619 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 3.43 (1.27) | 12.11 | 1, 2002 | 0.0005 |
| **Year (categorical)** | | 5.87 | 10, 25403 | <0.0001 |
| **Province (categorical)** | | 13.29 | 11, 25403 | <0.0001 |
| **Year*Province** | | 4.16 | 53, 25403 | <0.0001 |
| **Age** | -0.20 (0.04) | 22.42 | 1, 25403 | <0.0001 |
| **Sex (M=0; F=1)** | -0.23 (0.04) | 36.93 | 1, 25403 | <0.0001 |
| **EFSL (no=0; yes=1)** | 0.50 (0.06) | 67.66 | 1, 25403 | <0.0001 |
| **SES z-score** | -0.39 (0.02) | 278.45 | 1, 25403 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S14: Hierarchical Generalized Linear Model (HGLM) for the Communication Skills & General Knowledge (CSGK) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 2 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 6.02 (1.78) | 11.49 | 1, 2002 | 0.0007 |
| **Year (categorical)** | | 1.81 | 10, 26139 | 0.0527 |
| **Province (categorical)** | | 7.35 | 11, 26139 | <0.0001 |
| **Year*Province** | | 1.63 | 53, 26139 | 0.0027 |
| **Age** | 0.13 (0.06) | 5.09 | 1, 26139 | 0.0241 |
| **Sex (M=0; F=1)** | -0.43 (0.05) | 71.08 | 1, 26139 | <0.0001 |
| **EFSL (no=0; yes=1)** | 1.11 (0.08) | 173.83 | 1, 26139 | <0.0001 |
| **SES z-score** | -0.19 (0.03) | 54.80 | 1, 26139 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 2 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4-5 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5-6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 5 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5-6 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6 |
| Bias | 9 | Describe any efforts to address potential sources of bias | NA |
| Study size | 10 | Explain how the study size was arrived at | NA; population-level data |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 6-7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 6-7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | NA |
| | | (*c*) Explain how missing data were addressed | 7 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | 6 |
| | | (*e*) Describe any sensitivity analyses | 7 |

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| | | | |
|---|---|---|---|
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | NA; population-level database. |
| | | (b) Give reasons for non-participation at each stage | NA; population-level database. |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Tables 1 and 2 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Table S3 |
| Outcome data | 15* | Report numbers of outcome events or summary measures | |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Table 3<br><br>Although unadjusted estimates are not presented, VIF statistics were very low, indicating that predictor variables were not correlated with one another. When there is little to no correlation between predictor variables, unadjusted and adjusted effect estimates are likely very similar. |
| | | (*b*) Report category boundaries when continuous variables were categorized | NA |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 9 |

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| | | | |
|---|---|---|---|
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 9 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 11-12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 10-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 12-13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 13 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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# The socioeconomic gradient in the developmental health of children with disabilities at school-entry: a cross-sectional study



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**The socioeconomic gradient in the developmental health of children with disabilities at school-entry: a cross-sectional study**

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**Abstract**

***Objective:*** To examine the relationship between developmental health and neighborhood SES in kindergarten children with disabilities.

***Design:*** Cross-sectional study using population-level database of children's developmental health at school entry (2002 – 2014).

**Setting:** 12 of 13 Canadian provinces/territories.

***Measures:*** Taxfiler and Census data from 2005 and 2006, respectively, were aggregated according to custom-created neighborhood boundaries and used to create an index of neighborhood-level SES. Developmental health outcomes were measured using the Early Development Instrument (EDI) that evaluates developmental health across five domains and is completed by teachers in the second-half of the kindergarten year for every child in their class based on their observations of the child during the first half of the year.

**Analysis:** Hierarchical generalized linear models were used to test the association between neighborhood-level SES and developmental health.

***Results:*** All EDI domains were positively correlated with the neighborhood-level SES index. The strongest association was observed for the language & cognitive development domain (β (SE): 0.29 (0.02)) and the weakest association was observed for the emotional maturity domain (β (SE): 0.12 (0.01)).

***Conclusions:*** The magnitude of differences observed in EDI scores across neighborhoods at the 5$^{th}$ and 95$^{th}$ percentiles are similar to the effects of more established predictors of development, such as sex. The association of SES with developmental outcomes in this population may present a potential opportunity for policy interventions to improve immediate and longer-term outcomes.

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**Strengths and limitations of this study**

- Our investigation uses a large, representative population-level database, that allowed us to focus on children with disabilities that make up only a small proportion of the population, while also maximizing external validity and statistical power and minimizing potential selection bias.
- We used data from the EDI, a valid and reliable measure of children's developmental health.
- We focused on early childhood, a time that has been well documented to critically impact children's long-term academic and social trajectory.
- We applied a non-categorical approach to childhood disabilities that reflects current thinking in the field of child development.
- The study's limitation is the exclusive use of neighborhood-level socioeconomic status indicators, without the ability to control for family-level ones.

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**Introduction**

To date, associations between a number of health outcomes and a combination of economic, human, and social characteristics, commonly conceptualized as socioeconomic gradients, have been reported, including end-stage renal disease, breast cancer, obesity, and cardiometabolic health.[1-6] These studies have mostly focused on chronic conditions in adulthood, with studies on the socioeconomic determinants of child health emerging only more recently.[7-11]

A socioeconomic gradient in typically developing children's developmental health has been reported in a number of high-, middle-, and low-income countries,[12-14] including Canada.[8 15-17] Additionally, the prevalence of childhood disabilities has been consistently shown to be negatively associated with SES.[18] Stabile & Currie (2003) used data from the Canadian National Longitudinal Survey of Children and Youth (NLSCY) for children between 0 and 11 years of age to illustrate an inverse relationship between the prevalence of chronic childhood disabilities and SES.[19] Msall and colleagues (2007) reported a more than three-fold difference in disability rates between children living in distressed vs. advantaged neighborhoods in Rhode Island.[20] However, little is known about the relationship between SES and developmental outcomes in children with special needs . Existing evidence most often addresses specific diagnoses during middle childhood, is not representative of all disabilities experienced by children during early childhood, and does not consider the impact of SES outside of the immediate family environment (i.e., neighborhood SES) which has been shown to be a significant influence on developmental outcomes in typically developing children.[8 21 22,23] Understanding determinants of developmental health in early childhood can help in identifying groups of children with disabilities that are likely to be most at risk for worse academic and social outcomes later in life. Such identification is useful for policy planning and the provision of health and education services. The objective of this study is to determine if there is a socioeconomic gradient in the developmental health of children with disabilities at school entry. This work extends existing research in that it focuses on

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early childhood, a time at which experiences set the trajectory for future academic and social outcomes, takes a diagnosis-free, non-categorical approach to childhood disability, and uses population-level data.

## Methods

The project was approved by the Hamilton Integrated Research Ethics Board (no. 2403).

### *Patient and Public Involvement*

Patients/the public were not involved in the design or conduct of this study.

### *Data Source and Measurement*

Data for this study come from a Pan-Canadian database on early childhood development.[8 24] The database includes cross-sectional data from all Canadian provincial implementations between 2004 and 2014 of the Early Development Instrument (EDI), a population-level instrument developed by Janus and Offord (2007). The EDI is used to evaluate children's developmental health outcomes during the kindergarten year across five core domains: physical health & wellbeing, social competence, emotional maturity, language & cognitive development, and communication skills & general knowledge.[25] The EDI is completed by teachers in the second half of the kindergarten year (the year before Grade 1) - usually between February and March - based on their observations of each child. It is comprised of 103 core items, and domain scores range from 0 to 10, with higher scores indicating better developmental health. The EDI has been validated extensively for both typically-developing children[25-34] and those with disabilities.[35]

The database also includes data on children's age, sex, and whether they have a "special needs" designation.[24] The "special needs" designation is the operational indicator of childhood disability in our study. Definitions of "special needs" are set by each province/territory,[36 37] but they are similar and generally include children with identified health problems, with or without formal medical diagnoses, that impede their ability to learn in a regular classroom. Children encompassed by this definition have a broad range of impairments, varying widely in both type (e.g., physical or mental) and severity (e.g., mild

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speech impairment to non-verbal). The most common disabilities in this population include learning disabilities and speech impairments, which is consistent with the prevalence of disabilities in children at school entry in developed countries.[38 39] The EDI database has been linked to Canadian Census and Taxfiler data from 2006 and 2005, respectively, using custom-created neighborhood boundaries.[40] Briefly, the neighborhood boundaries were defined using Statistics Canada's dissemination blocks and were created to contain a minimum of 50 and a maximum of 600 valid EDI records per neighborhood. The criterion of having at least 50 EDI records per neighborhood was based on empirical data on EDI reliability. The custom-created neighborhood boundaries were based on existing administrative and geographic divisions and were created in consultation with provincial/territorial governments, to maximize their meaningfulness. Guhn et al. (2016) provide a more detailed description of the process for neighborhood boundary definition.[40] Census and Taxfiler variables were used to create the Canadian Neighborhoods and Early Child Development (CanNECD) SES index, which includes indicators of education, language/immigration, marital status, wealth, income, dues, social capital, poverty, residential stability, and income inequality (Table S1).

***Analysis***

All data analyses were conducted in SAS™ software using the GLIMMIX procedure.[41] Given that EDI domain scores are skewed and restricted in range, and that children are clustered within neighborhoods and schools, the data were analyzed using hierarchical generalized linear modeling (HGLM). The fit of a range of distributions and link functions were assessed and it was found that the identify link and gamma distribution produced the best model fit. EDI data were transformed by subtraction from 11 to allow for the gamma distribution to accommodate the left skew. Although children are clustered within two levels (neighborhoods and schools), only neighborhood of residence was included as a cluster variable due to data sparseness.[42] All models were performed using the Laplace approximation that

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allows estimation of likelihood statistics and has been shown to perform well with regard to accuracy and precision.[43]

EDI domain scores were used as the dependent variable. For each EDI domain, the analysis was performed hierarchically in three steps. First, an intercept-only model was constructed. Second, a model with child-level characteristics that have been found to be significant predictors of children's developmental health (i.e., age, sex, and English/French language learner status (EFSL)) as fixed-effects was constructed.[25 38] Additionally, year of data collection, province, and the interaction between the two were included as categorical variables to control for variations in data collection procedures across time points and provinces. Finally, to evaluate the association between neighborhood-level SES and children's developmental health, the SES index was added in the third model. Random effects of each of the individual predictors were added to the final model one-by-one and the overall improvement in the fit of the model was tested.

To assess whether the inclusion of child-level characteristics (age, sex, EFSL status), neighborhood-level SES, and random effects significantly improved model fit, partial likelihood ratio tests were performed, and goodness-of-fit indices (i.e., Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC)) were compared between models. Multicollinearity was tested by examining variance inflation factor (VIF) statistics for age, sex, EFSL status, and the SES index. VIF statistics for province of residence, time of data collection, and their interaction are not included as these were artificially inflated due to having been dummy coded and included as part of a regression model with few predictors. Leverage statistics, along with plots of raw, Pearson, and studentized residuals were used to identify outliers and influential observations. Observations with leverage statistics more than twice the mean of all leverage values were investigated for data entry error. A sensitivity analysis was conducted where observations with outlying studentized residuals, defined as studentized residuals with absolute values greater than two, were excluded in the estimation of the models. Cases with missing

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data were excluded from the analysis but were compared to those without missing data to ensure no substantial differences in demographic characteristics.

**Results**

***Population Characteristics***

A total of 29,520 children with disabilities were identified in the database. Population characteristics are presented in Table 1.

These children resided in 2,016 neighborhoods. Neighborhood characteristics are presented in Table 2. Forty (1.95%) neighborhoods in the database were excluded from the analysis due to not having any children with special needs (Table S2). These neighborhoods included fewer children overall, were of higher SES, and did not proportionally represent Canadian provinces as the majority were in Quebec.

Characteristics of children missing any one of the five EDI domain scores are presented in Table S3. Overall, only a small proportion of children (<2%) were missing data on any of the EDI domains and these children did not differ in demographic characteristics from the analytic sample.

***Model Results***

Regression coefficients, their levels of significance, and goodness-of-fit indices from the final model for each of the EDI domains are presented in Table 3. Additional details on each step of model development along with goodness-of-fit indices are presented in supplementary tables 4 through 8. The gamma distribution with an identity link produced the best fit for most domains, as assessed by AIC and BIC statistics (Table S9). Random effects of predictors did not significantly improve fit and so they were not included in the final model.

The results of the regression analysis indicate that both child-level characteristics and SES are significant predictors of children's EDI domain scores, as indicated by decreasing deviance, AIC, and BIC statistics across models, as well as significant likelihood ratio tests (supplementary tables 4 through 8).

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Year of data collection, province/territory, and the interaction between them were statistically significant for all domains. Age was statistically significant for all domains except physical health & wellbeing. Age was positively associated with language and cognitive development scores, and negatively with emotional maturity, social competence, and communication skills & general knowledge, with the largest effect sizes seen in the latter two domains and the smallest in physical health & wellbeing. Sex was statistically significant for all EDI domains and, on average, girls had higher scores than boys on all domains of the EDI, with the smallest sex differences in language & cognitive development, and largest in emotional maturity. English/French language learners had higher scores than non-learners in emotional maturity (smallest absolute effect) but lower scores in language & cognitive development and communication skills & general knowledge (largest absolute effect). The SES index was a statistically significant predictor of all EDI domains and was consistently positively associated with all domain scores. The smallest association was observed for the emotional maturity scores, and the largest for and language & cognitive development.

***Model Diagnostics and Sensitivity Analyses***

Excluding categorical variables, all VIF statistics were below the cut-off of 10 and ranged from 1.05 and 1.10. Studentized residuals were used to identify influential and outlying observations. The results of the sensitivity analysis excluding cases with absolute studentized residual values greater than 2 are presented in Table S10 through 14. The results from this sensitivity analysis were very similar to the results of the primary analysis.

**Discussion**

The objective of this investigation was to examine the association between neighborhood-level SES and developmental health in children with disabilities (operationally defined as “special needs” designation) at school entry, in order to determine the importance of contextual factors in predicting outcomes in this population. The results indicate that neighborhood-level SES is a consistent and significant predictor



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of developmental outcomes in this population. An average difference of 0.12 to 0.29 points in EDI domain scores was observed per standard deviation difference in SES, with higher EDI domain scores being observed in higher SES neighborhoods. Neighborhood-level SES had the strongest association with the language & cognitive development domain and the weakest with emotional maturity domain.

***Consistency with previous studies***

Comparing the magnitude of association between SES and developmental health with previous literature is difficult due to differences in the operationalization of these constructs and differences in analytic methods. Previous studies, mostly conducted with typically developing children,[12] have either explored the direct association between SES and developmental health[8 15-17 44] or investigated mediators of this relationship, including parent/child activities, access to a computer, participation in organized classes and activities, and maternal mental health.[45-47] Most of these studies measured SES at the individual family level and all demonstrated a positive association between social and economic variables and developmental health.

Among the studies done in typically developing populations, five use EDI outcomes, with four including neighborhood-level measures of SES.[8 15 17 48] All studies demonstrated a positive association between SES and the EDI. Webb et al. compared neighborhood effects in typically developing children using four published neighborhood SES indices.[8] Forer et al. examined the same association using the CanNECD index. Both these studies showed that the strength of association between the indices and EDI domains varied, depending on the domain and SES index used. Similar to our results, the strongest association was consistently found for the language & cognitive development domain.

The few studies done in children with disabilities also report a positive association between SES and academic and social outcomes.[21-23 49-51] These studies are different from the present investigation in that they only focus on a few high-incidence diagnoses, such as learning disabilities during middle childhood and adolescence and do not measure SES at the neighborhood-level.



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***Strengths and limitations***

There are several strengths of this study. First, we used population-level data, which made focusing on children with disabilities that only make up a small proportion of the population possible, while also maximizing external validity and statistical power and minimizing potential selection bias. Second, we focused on early childhood, a time that critically impacts children's long-term academic and social trajectory.[52] Third, we applied a non-categorical approach to childhood disabilities which reflects current thinking in the field of child development and findings that diagnostic categories often do not fully reflect the actual abilities and needs of children.[53-55] Fourth, the EDI has undergone extensive reliability and validity testing, and has been found to be predictive of academic achievement and social functioning throughout early and middle childhood.[25-34] The psychometric performance of the EDI in children with special needs has also been found similar to its performance in typically developing children.[35] Currently, the EDI is the only available indicator of developmental health that allows examination of variability across Canada at a population-level. Finally, the analytic methods used in this investigation appropriately take into account the skewed distribution and nesting of EDI data, which prevents artificially deflated standard errors and hence inappropriate statistically significant findings.

This investigation is also subject to limitations. First, due to the cross-sectional design of this study, causality cannot be established. There is evidence that developmental problems in children may increase parental stress and impact the general socioeconomic wellbeing of families.[56 57] Additionally, there is the possibility of self-selection where families with similar experiences may choose to reside within similar neighborhoods. Regardless of causality, or lack thereof, the results of this study indicate that services aimed at young children with disabilities that are particularly accessible in low SES neighborhoods are likely to be most impactful.

Second, we used a very broad definition of disability, which is based on the designation of the child by the education system at kindergarten, and hence, children with disabilities who did not have



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this designation by the education system were excluded. It is possible that a very small minority of children who were not typically developing but did not have this designation were excluded.

Third, the SES index may not accurately reflect the socioeconomic condition of the neighborhoods in which children were raised. The variables used to construct the SES index come from 2005 and 2006, whereas EDI data were collected between 2004 and 2014. It is possible that changes in neighborhoods or relocation of families could render the SES index less reflective of the true early environment for some groups of children, which may have led to underestimation of the association between SES and developmental outcomes. However, empirical evidence indicates that it is unlikely for neighborhood characteristics to drastically change over time or for families move to neighborhoods which are greatly different from their previous ones.[58] This appears to be confirmed by the remarkable stability of the CanNECD SES Index, the measure used in this study, over the period of five years.[48]

Finally, we were unable to control for family-level SES in the models. Thus, it is not possible to determine whether this association is driven by neighborhood or family characteristics. We were also unable to control for specific diagnoses or severity of disabilities that have undoubted impact on child development. Similar investigation should be extended for smaller subgroups of children who share diagnoses or functional impairments.

***Implications***

Our findings indicate that the relationship between SES and developmental outcomes also holds for children with disabilities.[8 15-17 44 59] This underscores the potential impact of the early environment of children on their development. Although clinicians often focus on biological factors, such as family history of disabilities and harmful exposures in utero, social influences have commonly been found to be more predictive of long-term developmental and academic outcomes and may be more amenable to change.[44] According to survey data, clinicians are receptive to screening for social determinants of health outside of the purview of clinical care, suggesting that the findings of this investigation are likely



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to be relevant and acceptable to those in the clinical community.[60] Our findings show that the association between child development and socioeconomic status, which is well-established for typically developing children, also exists for children with disabilities. This highlights the urgency for improving the social and economic context in which children are raised, in addition to targeted interventions delivered at the individual child level. Failure to do so will likely result in further perpetuation of inequities in child development – more so as children with disabilities are already among the most disadvantaged groups globally.[18 61] It remains to be seen whether large-scale policy interventions can help in reducing disparities in this population similarly to other groups.[62]

It is important to consider the findings in context of the availability of support services for children with special needs in Canada prior to school entry. The strategies, programs, and accessibility vary by province/territory, and often within jurisdictions, as municipal and regional health units are often service providers, but generally access is easier for children with a specific diagnosis than for those with unspecified disorders.[54] While there are no detailed studies on the potential association of service availability or magnitude of waiting lists with neighborhood SES per se, there could be at least two pathways to such relation. First, services tend to be located in large urban centres (with likely higher SES overall), where there are more professionals.[63 64] Second, navigation of the care systems, especially for preschool children rests largely on the shoulders of parents: the ability to do so effectively is likely associated with their personal and economic resources and where they live. [65 66]

Additional investigations could further strengthen and contextualize these findings. Specifically, establishing the consistency and relative strength of the relationship between SES and developmental outcomes across subgroups of physical, behavioral, and learning disabilities, as well as subgroups based on severity of condition and time of diagnosis, would further untangle the relationship between SES, disabilities, and development, and would be helpful in identifying service provision strategies that are likely to be most successful in improving outcomes.

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**Conclusion**

The results from this investigation show neighborhood SES to be significantly associated with the developmental health of children with disabilities at school entry. These findings have implications for policy planning and provision of health and educational service and draw attention to the universality of importance of contextual factors for development of all children.

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**Competing interests:** None.

**Contributions:** DZ, ED, TB, MJ, MG, BF, and MB conceived the study. DZ analyzed and ED provided technical expertise. DZ wrote the first draft of the manuscript and all authors made significant contributions to the manuscript.

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**Table 1: Population characteristics**

| **Sex** | **N (% of population of children with disabilities)** |
|---|---|
| Female | 8906 (30.2) |
| Male | 20585 (69.7) |
| Missing | 29 (0.1) |
| **Age** | |
| Mean (SD) | 5.79 (0.41) |
| Missing | 114 (0.39) |
| **EFSL Status** | **N (%)** |
| Yes | 3637 (12.3) |
| No | 25402 (86.0) |
| Missing | 481 (1.6) |
| **Province** | **N (%)** |
| Alberta | 2099 (7.1) |
| British Columbia | 5044 (17.1) |
| Manitoba | 2468 (8.4) |
| New Brunswick | 327 (1.1) |
| Newfoundland | 641 (2.2) |
| Nova Scotia | 1083 (3.7) |
| Northwest Territories | 65 (0.2) |
| Ontario | 13198 (44.7) |
| Prince Edward Island | 29 (0.1) |
| Quebec | 3023 (10.2) |
| Saskatchewan | 1440 (4.9) |
| Yukon | 103 (0.3) |
| **Year of data collection** | **N (%)** |
| 2004 | 474 (1.6) |
| 2005 | 2332 (7.9) |
| 2006 | 4304 (14.6) |
| 2007 | 1471 (5.0) |
| 2008 | 1762 (6.0) |
| 2009 | 4786 (16.2) |
| 2010 | 2658 (9.0) |
| 2011 | 3494 (11.8) |
| 2012 | 5140 (17.4) |
| 2013 | 2711 (9.2) |
| 2014 | 388 (1.3) |
| **Mean (SD) EDI domain scores** | |
| PHWB | 7.02 (2.12) |
| SC | 5.71 (2.63) |
| EM | 6.13 (1.99) |
| LCD | 6.18 (3.01) |
| CSGK | 4.37 (3.27) |

PHWB=Physical health & wellbeing; SC=Social competence; EM=Emotional maturity; LCD=Language & cognitive development; CSGK=communication skills & general knowledge

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**Table 2: Neighborhood characteristics (N=2016)**

| **Province** | **Number of neighborhoods (%)** |
|---|---|
| Alberta | 259 (12.8) |
| British Columbia | 298 (14.7) |
| Manitoba | 75 (3.7) |
| New Brunswick | 48 (2.4) |
| Newfoundland | 41 (2.0) |
| Nova Scotia | 57 (2.8) |
| Northwest Territories | 3 (0.1) |
| Ontario | 795 (39.4) |
| Prince Edward Island | 6 (0.3) |
| Quebec | 373 (18.5) |
| Saskatchewan | 55 (2.7) |
| Yukon | 6 (0.3) |
| **Median (IQR) number of children with disabilities in each neighborhood** | 11 (6 – 19) |
| **Median (IQR) number of children in each neighborhood** | 128 (87 – 194) |

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**Table 3: Final Hierarchical Generalized Linear Models (HGLMs) for the Early Development Instrument (EDI)**

| Variables | Physical health & wellbeing (PHWB) | Social competence (SC) | Emotional maturity (EM) | Language & cognitive development (LCD) | Communication skills & general knowledge (CSGK) |
|---|---|---|---|---|---|
| | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) |
| **Age** | -0.04 (-0.01 to 0.03) | -0.13 (-0.22 to -0.05) | -0.08 (-0.14 to -0.02) | 0.10 (0.01 to 0.18) | -0.13 (-0.24 to -0.02) |
| **Sex (M=0; F=1)** | 0.14 (0.08 to 0.19) | 0.76 (0.69 to 0.83) | 0.81 (0.76 to 0.86) | 0.13 (0.05 to 0.21) | 0.43 (0.33 to 0.53) |
| **EFSL (no=0; yes=1)** | 0.04 (-0.04 to 0.12) | -0.10 (-0.20 to 0.01) | 0.12 (0.05 to 0.20) | -0.43 (-0.56 to -0.31) | -1.11 (-0.94 to -1.27) |
| **SES z-score** | 0.17 (0.14 to 0.20) | 0.17 (0.13 to 0.21) | 0.12 (0.09 to 0.15) | 0.29 (0.24 to 0.33) | 0.19 (0.14 to 0.24) |

95% CIs=95% confidence intervals; EFSL=English/French as a second language; SES=socioeconomic status

Note that coefficient presented in this table reflect the directionality of the association between variables and untransformed EDI scores.

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**Table S1: Variables included in the Canadian Neighbourhoods and Early Child Development (CanNECD) socioeconomic status (SES) index**

| | |
|---|---|
| **Education** | % with no high school diploma |
| **Language/Immigration** | % not speaking either official language at home |
| **Marital Status** | % separated or divorced |
| **Wealth** | % with investment income, families with children under 6 |
| **High Income** | % with incomes ≥ twice than provincial median, families with children under 6 |
| **Dues** | % with union/association dues, families with children under 6 |
| **Social Capital** | % with charitable donations, families with children under 6 |
| **Poverty** | % with low income, lone parent families with children under 6 |
| **Residential Stability** | % non-migrant movers in the past year |
| **Income Inequality** | Gini Coefficient, lone female families with children under 6 |

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**Table S2: Descriptive characteristics of neighborhoods excluded from analysis (n=40)**

| Province | Number of neighborhoods (%) |
|---|---|
| **Alberta** | 8 (20) |
| **New Brunswick** | 4 (10) |
| **Ontario** | 5 (12.5) |
| **Quebec** | 23 (57.5) |
| **Median (IQR) number of children in each neighbourhood** | 83 (56-141) |
| **Mean (SD) of standardized SES index** | 0.38 (0.88) |

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**Table S3: Descriptive characteristics of population of children with missing Physical Health & Wellbeing (PHWB) scores (n=446)**

| | PHWB | SC | EM | LCD | CSGK |
|---|---|---|---|---|---|
| **Sex** | **N (%)** | | | | |
| Female | 123 (27.6) | 138 (30.5) | 166 (27.7) | 154 (28.4) | 128 (30.4) |
| Male | 318 (71.3) | 311 (68.7) | 429 (71.5) | 384 (70.8) | 289 (68.6) |
| Missing | 5 (1.1) | 4 (0.9) | 5 (0.8) | 4 (0.7) | 4 (1.0) |
| **Age** | | | | | |
| Mean (SD) | 5.78 (0.40) | 5.73 (0.4) | 5.78 (0.4) | 5.76 (0.4) | 5.76 (0.41) |
| Missing | 7 (1.57) | 6 (1.3) | 8 (1.3) | 6 (1.1) | 7 (1.66) |
| **EFSL Status** | **N (%)** | | | | |
| Yes | 61 (13.7) | 61 (13.5) | 76 (12.7) | 77 (14.2) | 59 (14.0) |
| No | 379 (85.0) | 386 (85.2) | 511 (85.2) | 457 (84.3) | 355 (84.3) |
| Missing | 6 (1.3) | 6 (1.3) | 13 (2.2) | 8 (1.5) | 7 (1.7) |
| **Province** | **N (%)** | | | | |
| Alberta | 82 (18.4) | 84 (18.5) | 92 (15.3) | 91 (16.8) | 85 (20.2) |
| British Columbia | 9 (2.0) | 17 (3.8) | 41 (6.8) | 45 (8.3) | 7 (1.7) |
| Manitoba | 122 (27.4) | 117 (25.8) | 131 (21.8) | 121 (22.3) | 113 (26.8) |
| New Brunswick | 1 (0.2) | 1 (0.2) | 4 (0.7) | 1 (0.2) | 0 (0) |
| Newfoundland | 3 (0.7) | 6 (1.3) | 6 (1.0) | 3 (0.6) | 5 (1.2) |
| Nova Scotia | 15 (3.4) | 14 (3.1) | 20 (3.3) | 21 (3.9) | 15 (3.6) |
| Northwest Territories | 1 (0.2) | 1 (0.2) | 2 (0.3) | 1 (0.2) | 1 (0.2) |
| Ontario | 193 (43.3) | 192 (42.4) | 241 (40.2) | 222 (41.0) | 173 (41.1) |
| Prince Edward Island | 0 (0) | 0 (0) | 0 (0) | 1 (0.2) | 0 (0) |
| Quebec | 5 (1.1) | 3 (0.7) | 33 (5.5) | 15 (2.8) | 7 (1.7) |
| Saskatchewan | 8 (1.8) | 13 (2.9) | 19 (3.2) | 14 (2.6) | 10 (2.4) |
| Yukon | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| **Year of data collection** | **N (%)** | | | | |
| 2004 | 3 (0.7) | 3 (0.7) | 7 (1.2) | 3 (0.6) | 2 (0.5) |
| 2005 | 19 (4.3) | 17 (3.8) | 29 (4.8) | 21 (3.9) | 12 (2.9) |
| 2006 | 46 (10.3) | 44 (9.7) | 77 (12.8) | 61 (11.3) | 46 (10.9) |
| 2007 | 26 (5.8) | 23 (5.1) | 39 (6.5) | 32 (5.9) | 21 (5.0) |
| 2008 | 33 (7.4) | 34 (7.5) | 43 (7.2) | 39 (7.2) | 32 (7.6) |
| 2009 | 50 (11.2) | 55 (12.1) | 70 (11.7) | 69 (12.7) | 43 (10.2) |
| 2010 | 51 (11.4) | 48 (10.6) | 57 (9.5) | 58 (10.7) | 43 (10.2) |
| 2011 | 96 (21.5) | 96 (21.2) | 113 (18.8) | 113 (20.8) | 97 (23.0) |
| 2012 | 51 (11.4) | 56 (12.4) | 80 (13.3) | 67 (12.4) | 53 (12.6) |
| 2013 | 71 (15.9) | 74 (16.3) | 84 (14.0) | 79 (14.6) | 72 (17.1) |
| 2014 | 0 (0) | 3 (0.7) | 1 (0.2) | 0 (0) | 0 (0) |
| **Mean (SD) EDI domain scores** | | | | | |
| PHWB | NA | 5.06 (2.17) | 6.70 (2.33) | 6.82 (2.09) | 7.71 (1.96) |
| SC | 5.42 (2.97) | NA | 5.47 (2.54) | 4.78 (2.33) | 5.97 (2.98) |
| EM | 5.90 (2.53) | 5.42 (1.44) | NA | 5.65 (1.89) | 6.31 (1.36) |
| LCD | 5.39 (3.31) | 1.98 (2.38) | 5.51 (3.15) | NA | 6.29 (3.46) |
| CSGK | 3.80 (3.34) | 0.86 (1.91) | 3.77 (3.06) | 2.93 (2.74) | NA |

PHWB=Physical health & wellbeing; SC=Social competence; EM=Emotional maturity; LCD=Language & cognitive development; CSGK=communication skills & general knowledge

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**Table S4: Hierarchical Generalized Linear Model (HGLM) for the Physical Health & Wellbeing (PHWB) main of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | DF | P-value | B coefficient (SE) | F-statistic | DF | P-value | B coefficient (SE) | F-statistic | DF | P-value |
| **Intercept** | 3.98 (0.02) | 47093.34 | 1, 2013 | <0.0001 | 4.75 (1.07) | 19.80 | 1, 2002 | <0.0001 | 4.65 (1.07) | 19.10 | 1, 2002 | <0.0001 |
| **Year (categorical)** | | | | | | 3.95 | 10, 26117 | <0.0001 | | 4.18 | 10, 26116 | <0.0001 |
| **Province (categorical)** | | | | | | 13.94 | 11, 26117 | <0.0001 | | 13.54 | 11, 26116 | <0.0001 |
| **Year*Province** | | | | | | 2.54 | 53, 26117 | <0.0001 | | 2.91 | 53, 26116 | <0.0001 |
| **Age** | | | | | 0.03 (0.03) | 1.04 | 1, 26117 | 0.3089 | 0.04 (0.03) | 1.29 | 1, 26116 | 0.2558 |
| **Sex (M=0; F=1)** | | | | | -0.13 (0.03) | 22.96 | 1, 26117 | <0.0001 | -0.14 (0.03) | 24.11 | 1, 26116 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | -0.02 (0.04) | 0.19 | 1, 26117 | 0.6638 | -0.04 (0.04) | 0.94 | 1, 26116 | 0.3325 |
| **SES z-score** | | | | | | | | | -0.17 (0.02) | 116.76 | 1, 26116 | <0.0001 |
| **Deviance** | 118982.4 | | | | 118334.9 | | | | 118222.1 | | | |
| **AIC** | 118988.4 | | | | 118494.9 | | | | 118384.1 | | | |
| **BIC** | 119005.2 | | | | 118943.5 | | | | 118838.4 | | | |
| **Pearson Chi-Square** | 7394.78 | | | | 7475.81 | | | | 7495.20 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S5: Hierarchical Generalized Linear Model (HGLM) for the Social Competence (SC) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 5.31 (0.02) | 62975.90 | 1, 2014 | <0.0001 | 4.62 (1.26) | 13.47 | 1, 2004 | 0.0003 | 4.46 (1.25) | 12.67 | 1, 2003 | 0.0004 |
| **Year (categorical)** | | | | | | 2.83 | 10, 26106 | 0.0016 | | 2.56 | 10, 26106 | 0.0043 |
| **Province (categorical)** | | | | | | 10.27 | 11, 26106 | <0.0001 | | 10.25 | 11, 26106 | <0.0001 |
| **Year*Province** | | | | | | 2.76 | 53, 26106 | <0.0001 | | 2.76 | 53, 26106 | <0.0001 |
| **Age** | | | | | 0.13 (0.04) | 8.99 | 1, 26106 | 0.0027 | 0.13 (0.04) | 10.12 | 1, 26106 | 0.0015 |
| **Sex (M=0; F=1)** | | | | | -0.75 (0.04) | 439.63 | 1, 26106 | <0.0001 | -0.76 (0.04) | 447.29 | 1, 26106 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | 0.12 (0.06) | 4.82 | 1, 26106 | 0.0284 | 0.10 (0.05) | 3.07 | 1, 26106 | 0.0798 |
| **SES z-score** | | | | | | | | | -0.17 (0.02) | 69.10 | 1, 26106 | <0.0001 |
| **Deviance** | 134806.2 | | | | 134020.8 | | | | 133955.4 | | | |
| **AIC** | 134812.2 | | | | 134180.8 | | | | 134117.4 | | | |
| **BIC** | 134829.0 | | | | 134629.5 | | | | 134571.7 | | | |
| **Pearson Chi-Square** | 6654.52 | | | | 6723.87 | | | | 6736.70 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S6: Hierarchical Generalized Linear Model (HGLM) for the Emotional Maturity (EM) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 4.88 (0.02) | 47093.34 | 1, 2014 | <0.0001 | 4.28 (0.96) | 19.71 | 1, 2003 | <0.0001 | 4.18 (0.95) | 19.00 | 1, 2003 | <0.0001 |
| **Year (categorical)** | | | | | | 2.68 | 10, 25974 | 0.0029 | | 2.42 | 10, 25793 | <0.0001 |
| **Province (categorical)** | | | | | | 9.22 | 11, 25974 | <0.0001 | | 9.04 | 11, 25793 | <0.0001 |
| **Year*Province** | | | | | | 2.12 | 53, 25974 | <0.0001 | | 2.06 | 53, 25793 | <0.0001 |
| **Age** | | | | | 0.08 (0.03) | 6.17 | 1, 25974 | 0.0130 | 0.08 (0.03) | 6.63 | 1, 25793 | 0.0101 |
| **Sex (M=0; F=1)** | | | | | -0.81 (0.03) | 970.94 | 1, 25974 | <0.0001 | -0.81 (0.03) | 969.06 | 1, 25793 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | -0.11 (0.04) | 7.29 | 1, 25974 | 0.0070 | -0.12 (0.04) | 10.01 | 1, 25793 | 0.0016 |
| **SES z-score** | | | | | | | | | -0.12 (0.01) | 65.82 | 1, 25793 | <0.0001 |
| **Deviance** | 119448.7 | | | | 118202.7 | | | | 118136.1 | | | |
| **AIC** | 119454.7 | | | | 118362.7 | | | | 118298.1 | | | |
| **BIC** | 119471.6 | | | | 118811.3 | | | | 118752.3 | | | |
| **Pearson Chi-Square** | 4465.48 | | | | 4421.32 | | | | 4428.30 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S7: Hierarchical Generalized Linear Model (HGLM) for the Language & Cognitive Development (LCD) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 4.82 (0.02) | 37229.70 | 1, 2014 | <0.0001 | 4.36 (1.33) | 10.69 | 1, 2003 | 0.0011 | 4.17 (1.33) | 9.80 | 1, 2003 | 0.0017 |
| **Year (categorical)** | | | | | | 3.78 | 10, 26022 | 0.0029 | | 3.49 | 10, 26021 | <0.0001 |
| **Province (categorical)** | | | | | | 6.32 | 11, 26022 | <0.0001 | | 7.01 | 11, 26021 | <0.0001 |
| **Year*Province** | | | | | | 2.13 | 53, 26022 | <0.0001 | | 2.28 | 53, 26021 | <0.0001 |
| **Age** | | | | | -0.11 (0.04) | 6.34 | 1, 26022 | 0.0118 | -0.10 (0.04) | 5.01 | 1, 26021 | 0.0252 |
| **Sex (M=0; F=1)** | | | | | -0.13 (0.04) | 10.35 | 1, 26022 | 0.0013 | -0.13 (0.04) | 10.42 | 1, 26021 | 0.0013 |
| **EFSL (no=0; yes=1)** | | | | | 0.48 (0.06) | 58.32 | 1, 26022 | <0.0001 | 0.43 (0.06) | 47.13 | 1, 26021 | <0.0001 |
| **SES z-score** | | | | | | | | | -0.29 (0.02) | 160.80 | 1, 26021 | <0.0001 |
| **Deviance** | 135595.0 | | | | 135045.0 | | | | 134891.0 | | | |
| **AIC** | 135601.0 | | | | 135205.0 | | | | 135053.0 | | | |
| **BIC** | 135617.8 | | | | 135653.7 | | | | 135507.3 | | | |
| **Pearson Chi-Square** | 10372.47 | | | | 10458.52 | | | | 10531.822 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S8: Hierarchical Generalized Linear Model (HGLM) for the Communication Skills & General Knowledge (CSGK) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 6.65 (0.03) | 63312.62 | 1, 2014 | <0.0001 | 6.11 (1.78) | 11.76 | 1, 2003 | 0.0006 | 4.65 (1.07) | 19.10 | 1, 2002 | 0.0007 |
| **Year (categorical)** | | | | | | 3.95 | 10, 26141 | 0.0247 | | 1.74 | 10, 26140 | 0.0657 |
| **Province (categorical)** | | | | | | 13.94 | 11, 26141 | <0.0001 | | 5.94 | 11, 26140 | <0.0001 |
| **Year*Province** | | | | | | 2.54 | 53, 26141 | 0.0109 | | 1.51 | 53, 26140 | 0.0094 |
| **Age** | | | | | 0.13 (0.06) | 2.05 | 1, 26141 | 0.0258 | 0.13 (0.05) | 5.19 | 1, 26140 | 0.0227 |
| **Sex (M=0; F=1)** | | | | | -0.42 (0.05) | 7.24 | 1, 26141 | <0.0001 | -0.43 (0.05) | 70.12 | 1, 26140 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | 1.15 (0.08) | 1.50 | 1, 26141 | <0.0001 | 1.11 (0.08) | 173.86 | 1, 26140 | <0.0001 |
| **SES z-score** | | | | | | | | | -0.19 (0.02) | 55.05 | 1, 26140 | <0.0001 |
| **Deviance** | 151991.9 | | | | 151438.8 | | | | 151384.1 | | | |
| **AIC** | 151997.9 | | | | 151598.8 | | | | 151544.1 | | | |
| **BIC** | 152014.7 | | | | 152047.5 | | | | 151992.8 | | | |
| **Pearson Chi-Square** | 6272.57 | | | | 6810.50 | | | | 6817.77 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S9: Goodness-of-fit of different distributions and link functions for the social competence domain**

| | | Identity link | | | Log link | | |
|---|---|---|---|---|---|---|---|
| **Domain** | **Goodness-of-fit statistics** | **Exponential** | **Gamma** | **Normal** | **Exponential** | **Gamma** | **Normal** |
| **Physical health & wellbeing (PHWB)** | AIC | 134241.6 | 118384.1 | 121141.6 | 134240.4 | 118399.9 | 121147.4 |
| | BIC | 134684.7 | 118838.4 | 121595.8 | 134683.5 | 118854.2 | 121601.6 |
| **Social competence (SC)** | AIC | 150247.6 | 113417.4 | 133234.4 | 150247.5 | 134128.9 | NC |
| | BIC | 150690.7 | 134571.7 | 133688.7 | 150690.6 | 134583.2 | NC |
| **Emotional maturity (EM)** | AIC | 144859.5 | 118298.1 | 116476.9 | 144859.8 | 118310 | NC |
| | BIC | 145302.6 | 118752.3 | 116931.2 | 145302.8 | 118764.3 | NC |
| **Language & cognitive development (LCD)** | AIC | 144457.3 | 135053.0 | 140742 | 144457.1 | 135069.7 | 140754.4 |
| | BIC | 144900.3 | 135507.3 | 141196.3 | 144900.2 | 135524 | 141208.7 |
| **Communication skills & general knowledge (CSGK)** | AIC | 163276.5 | 151544.1 | 146002.4 | 163274.7 | 151539.4 | NC |
| | BIC | 163719.5 | 151992.8 | 146456.7 | 163717.8 | 151988.1 | NC |

AIC=Akaike information criterion; BIC=Bayesian information criterion; NC=not converged

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**Table S10: Hierarchical Generalized Linear Model (HGLM) for the Physical Health & Wellbeing (PHWB) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 687 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 4.70 (1.03) | 20.70 | 1, 1999 | <0.0001 |
| **Year (categorical)** | | 6.03 | 10, 25432 | <0.0001 |
| **Province (categorical)** | | 19.14 | 11, 25432 | <0.0001 |
| **Year*Province** | | 4.14 | 53, 25432 | <0.0001 |
| **Age** | 0.02 (0.03) | 0.63 | 1, 25432 | 0.4265 |
| **Sex (M=0; F=1)** | -0.21 (0.03) | 60.10 | 1, 25432 | <0.0001 |
| **EFSL (no=0; yes=1)** | -0.09 (0.04) | 5.07 | 1, 25432 | 0.0243 |
| **SES z-score** | -0.19 (0.02) | 4.14 | 1, 25432 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S11: Hierarchical Generalized Linear Model (HGLM) for the Social Competence (SC) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 317 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 4.54 (1.24) | 13.47 | 1, 2002 | 0.0003 |
| **Year (categorical)** | | 5.26 | 10, 25790 | <0.0001 |
| **Province (categorical)** | | 14.83 | 11, 25790 | <0.0001 |
| **Year*Province** | | 4.43 | 53, 25790 | <0.0001 |
| **Age** | 0.13 (0.04) | 9.48 | 1, 25790 | 0.0021 |
| **Sex (M=0; F=1)** | -0.94 (0.03) | 736.81 | 1, 25790 | <0.0001 |
| **EFSL (no=0; yes=1)** | 0.07 (0.05) | 1.74 | 1, 25790 | 0.1862 |
| **SES z-score** | -0.18 (0.02) | 86.23 | 1, 25790 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S12: Hierarchical Generalized Linear Model (HGLM) for the Emotional Maturity (EM) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 409 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 3.36 (0.91) | 13.54 | 1, 2001 | 0.0002 |
| **Year (categorical)** | | 3.84 | 10, 25566 | <0.0001 |
| **Province (categorical)** | | 12.32 | 11, 25566 | <0.0001 |
| **Year*Province** | | 3.04 | 53, 25566 | <0.0001 |
| **Age** | 0.10 (0.03) | 10.68 | 1, 25566 | 0.0011 |
| **Sex (M=0; F=1)** | -0.91 (0.03) | 1307.36 | 1, 25566 | <0.0001 |
| **EFSL (no=0; yes=1)** | -0.13 (0.04) | 11.97 | 1, 25566 | 0.0005 |
| **SES z-score** | -0.14 (0.01) | 88.74 | 1, 25566 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S13: Hierarchical Generalized Linear Model (HGLM) for the Language & Cognitive Development (LCD) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 619 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 3.43 (1.27) | 12.11 | 1, 2002 | 0.0005 |
| **Year (categorical)** | | 5.87 | 10, 25403 | <0.0001 |
| **Province (categorical)** | | 13.29 | 11, 25403 | <0.0001 |
| **Year*Province** | | 4.16 | 53, 25403 | <0.0001 |
| **Age** | -0.20 (0.04) | 22.42 | 1, 25403 | <0.0001 |
| **Sex (M=0; F=1)** | -0.23 (0.04) | 36.93 | 1, 25403 | <0.0001 |
| **EFSL (no=0; yes=1)** | 0.50 (0.06) | 67.66 | 1, 25403 | <0.0001 |
| **SES z-score** | -0.39 (0.02) | 278.45 | 1, 25403 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S14: Hierarchical Generalized Linear Model (HGLM) for the Communication Skills & General Knowledge (CSGK) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 2 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 6.02 (1.78) | 11.49 | 1, 2002 | 0.0007 |
| **Year (categorical)** | | 1.81 | 10, 26139 | 0.0527 |
| **Province (categorical)** | | 7.35 | 11, 26139 | <0.0001 |
| **Year*Province** | | 1.63 | 53, 26139 | 0.0027 |
| **Age** | 0.13 (0.06) | 5.09 | 1, 26139 | 0.0241 |
| **Sex (M=0; F=1)** | -0.43 (0.05) | 71.08 | 1, 26139 | <0.0001 |
| **EFSL (no=0; yes=1)** | 1.11 (0.08) | 173.83 | 1, 26139 | <0.0001 |
| **SES z-score** | -0.19 (0.03) | 54.80 | 1, 26139 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 2 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4-5 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5-6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 5 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5-6 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6 |
| Bias | 9 | Describe any efforts to address potential sources of bias | NA |
| Study size | 10 | Explain how the study size was arrived at | NA; population-level data |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 6-7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 6-7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | NA |
| | | (*c*) Explain how missing data were addressed | 7 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | 6 |
| | | (*e*) Describe any sensitivity analyses | 7 |

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| | | | |
|---|---|---|---|
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | NA; population-level database. |
| | | (b) Give reasons for non-participation at each stage | NA; population-level database. |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Tables 1 and 2 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Table S3 |
| Outcome data | 15* | Report numbers of outcome events or summary measures | |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Table 3<br><br>Although unadjusted estimates are not presented, VIF statistics were very low, indicating that predictor variables were not correlated with one another. When there is little to no correlation between predictor variables, unadjusted and adjusted effect estimates are likely very similar. |
| | | (*b*) Report category boundaries when continuous variables were categorized | NA |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 9 |

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| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 9 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 11-12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 10-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 12-13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 13 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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# The socioeconomic gradient in the developmental health of Canadian children with disabilities at school-entry: a cross-sectional study

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**The socioeconomic gradient in the developmental health of Canadian children with disabilities at school-entry: a cross-sectional study**

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**Abstract**

***Objective:*** To examine the relationship between developmental health and neighborhood socioeconomic status (SES) in kindergarten children with disabilities.

***Design:*** Cross-sectional study using population-level database of children's developmental health at school entry (2002 – 2014).

**Setting:** 12 of 13 Canadian provinces/territories.

***Measures:*** Taxfiler and Census data from 2005 and 2006, respectively, were aggregated according to custom-created neighborhood boundaries and used to create an index of neighborhood-level SES. Developmental health outcomes were measured for 29,520 children with disabilities using the Early Development Instrument (EDI), a teacher-completed measure of developmental health across five domains.

**Analysis:** Hierarchical generalized linear models were used to test the association between neighborhood-level SES and developmental health.

***Results:*** All EDI domains were positively correlated with the neighborhood-level SES index. The strongest association was observed for the language & cognitive development domain (β (SE): 0.29 (0.02)) and the weakest association was observed for the emotional maturity domain (β (SE): 0.12 (0.01)).

***Conclusions:*** The magnitude of differences observed in EDI scores across neighborhoods at the 5$^{th}$ and 95$^{th}$ percentiles are similar to the effects of more established predictors of development, such as sex. The association of SES with developmental outcomes in this population may present a potential opportunity for policy interventions to improve immediate and longer-term outcomes.

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**Strengths and limitations of this study**

- Our investigation uses a large, representative population-level database, that allowed us to focus on children with disabilities that make up only a small proportion of the population, while also maximizing external validity and statistical power and minimizing potential selection bias.
- We used data from the EDI, a valid and reliable measure of children's developmental health.
- We focused on early childhood, a time that has been well documented to critically impact children's long-term academic and social trajectory.
- We applied a non-categorical approach to childhood disabilities that reflects current thinking in the field of child development.
- The study's limitation is the exclusive use of neighborhood-level socioeconomic status indicators, without the ability to control for family-level ones.

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**Introduction**

To date, associations between a number of health outcomes and a combination of economic, human, and social characteristics, commonly conceptualized as socioeconomic gradients, have been reported, including end-stage renal disease, breast cancer, obesity, and cardiometabolic health.[1-6] These studies have mostly focused on chronic conditions in adulthood, with studies on the socioeconomic determinants of child health emerging only more recently.[7-11]

A socioeconomic gradient in typically developing children's developmental health has been reported in a number of high-, middle-, and low-income countries,[12-14] including Canada.[8 15-17] Additionally, the prevalence of childhood disabilities has been consistently shown to be negatively associated with socioeconomic status (SES).[18] Stabile & Currie (2003) used data from the Canadian National Longitudinal Survey of Children and Youth (NLSCY) for children between 0 and 11 years of age to illustrate an inverse relationship between the prevalence of chronic childhood disabilities and SES.[19] Msall and colleagues (2007) reported a more than three-fold difference in disability rates between children living in distressed vs. advantaged neighborhoods in Rhode Island.[20] However, little is known about the relationship between SES and developmental outcomes in children with special needs . Existing evidence most often addresses specific diagnoses during middle childhood, is not representative of all disabilities experienced by children during early childhood, and does not consider the impact of SES outside of the immediate family environment (i.e., neighborhood SES) which has been shown to be a significant influence on developmental outcomes in typically developing children.[8 21 22,23] Understanding determinants of developmental health in early childhood can help in identifying groups of children with disabilities that are likely to be most at risk for worse academic and social outcomes later in life. Such identification is useful for policy planning and the provision of health and education services. The objective of this study is to determine if there is a socioeconomic gradient in the developmental health of children with disabilities at school entry. This work extends existing research in

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that it focuses on early childhood, a time at which experiences set the trajectory for future academic and social outcomes, takes a diagnosis-free, non-categorical approach to childhood disability, and uses population-level data.

## Methods

The project was approved by the Hamilton Integrated Research Ethics Board (no. 2403).

### *Patient and Public Involvement*

Patients/the public were not involved in the design or conduct of this study.

### *Data Source and Measurement*

Data for this study come from a Pan-Canadian database on early childhood development, which is held at the Offord Centre for Child Studies at McMaster University, a national repository for this database.[8 24 25] The database includes cross-sectional data from all Canadian provincial implementations between 2004 and 2014 of the Early Development Instrument (EDI), a population-level instrument developed by Janus and Offord (2007). The EDI is used to evaluate children's developmental health outcomes during the kindergarten year across five core domains: physical health & wellbeing, social competence, emotional maturity, language & cognitive development, and communication skills & general knowledge.[26] The EDI is completed by teachers in the second half of the kindergarten year (the year before Grade 1) - usually between February and March - based on their observations of each child. It is comprised of 103 core items, and domain scores range from 0 to 10, with higher scores indicating better developmental health. Permission to collect EDI data on kindergarten children was obtained from the respective provincial and territorial governments. With the exception of the province of Alberta, which required written consent from parents, data were collected via passive consent. The EDI has been validated extensively for both typically-developing children[26-35] and those with disabilities.[36]

The database also includes data on children's age, sex, and whether they have a "special needs" designation.[24] The "special needs" designation is the operational indicator of childhood disability in our



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study. Definitions of "special needs" are set by each province/territory,[37 38] but they are similar and generally include children with identified health problems, with or without formal medical diagnoses, that impede their ability to learn in a regular classroom. Children encompassed by this definition have a broad range of impairments, varying widely in both type (e.g., physical or mental) and severity (e.g., mild speech impairment to non-verbal). The most common disabilities in this population include learning disabilities and speech impairments, which is consistent with the prevalence of disabilities in children at school entry in developed countries.[39 40] The EDI database has been linked to Canadian Census and Taxfiler data from 2006 and 2005, respectively, using custom-created neighborhood boundaries.[41] Briefly, the neighborhood boundaries were defined using Statistics Canada's dissemination blocks and were created to contain a minimum of 50 and a maximum of 600 valid EDI records per neighborhood. The criterion of having at least 50 EDI records per neighborhood was based on empirical data on EDI reliability. The custom-created neighborhood boundaries were based on existing administrative and geographic divisions and were created in consultation with provincial/territorial governments, to maximize their meaningfulness. Guhn et al. (2016) provide a more detailed description of the process for neighborhood boundary definition.[41] Census and Taxfiler variables were used to create the Canadian Neighborhoods and Early Child Development (CanNECD) SES index, which includes indicators of education, language/immigration, marital status, wealth, income, dues, social capital, poverty, residential stability, and income inequality (Table S1).

***Analysis***

All data analyses were conducted in SAS™ software using the GLIMMIX procedure.[42] Given that EDI domain scores are skewed and restricted in range, and that children are clustered within neighborhoods and schools, the data were analyzed using hierarchical generalized linear modeling (HGLM). The fit of a range of distributions and link functions were assessed and it was found that the identify link and gamma distribution produced the best model fit. EDI data were transformed by subtraction from 11 to

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allow for the gamma distribution to accommodate the left skew. Although children are clustered within two levels (neighborhoods and schools), only neighborhood of residence was included as a cluster variable due to data sparseness.[43] All models were performed using the Laplace approximation that allows estimation of likelihood statistics and has been shown to perform well with regard to accuracy and precision.[44]

EDI domain scores were used as the dependent variable. For each EDI domain, the analysis was performed hierarchically in three steps. First, an intercept-only model was constructed. Second, a model with child-level characteristics that have been found to be significant predictors of children's developmental health (i.e., age, sex, and English/French language learner status (EFSL)) as fixed-effects was constructed.[26 39] Additionally, year of data collection, province, and the interaction between the two were included as categorical variables to control for variations in data collection procedures across time points and provinces. Finally, to evaluate the association between neighborhood-level SES and children's developmental health, the SES index was added in the third model. Random effects of each of the individual predictors were added to the final model one-by-one and the overall improvement in the fit of the model was tested.

To assess whether the inclusion of child-level characteristics (age, sex, EFSL status), neighborhood-level SES, and random effects significantly improved model fit, partial likelihood ratio tests were performed, and goodness-of-fit indices (i.e., Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC)) were compared between models. Multicollinearity was tested by examining variance inflation factor (VIF) statistics for age, sex, EFSL status, and the SES index. VIF statistics for province of residence, time of data collection, and their interaction are not included as these were artificially inflated due to having been dummy coded and included as part of a regression model with few predictors. Leverage statistics, along with plots of raw, Pearson, and studentized residuals were used to identify outliers and influential observations. Observations with leverage statistics more than

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twice the mean of all leverage values were investigated for data entry error. A sensitivity analysis was conducted where observations with outlying studentized residuals, defined as studentized residuals with absolute values greater than two, were excluded in the estimation of the models. Cases with missing data were excluded from the analysis but were compared to those without missing data to ensure no substantial differences in demographic characteristics.

**Results**

***Population Characteristics***

A total of 29,520 children with disabilities were identified in the database. Population characteristics are presented in Table 1.

These children resided in 2,016 neighborhoods. Neighborhood characteristics are presented in Table 2. Forty (1.95%) neighborhoods in the database were excluded from the analysis due to not having any children with special needs (Table S2). These neighborhoods included fewer children overall, were of higher SES, and did not proportionally represent Canadian provinces as the majority were in Quebec.

Characteristics of children missing any one of the five EDI domain scores are presented in Table S3. Overall, only a small proportion of children (<2%) were missing data on any of the EDI domains and these children did not differ in demographic characteristics from the analytic sample.

***Model Results***

Regression coefficients, their levels of significance, and goodness-of-fit indices from the final model for each of the EDI domains are presented in Table 3. Additional details on each step of model development along with goodness-of-fit indices are presented in supplementary tables 4 through 8. The gamma distribution with an identity link produced the best fit for most domains, as assessed by AIC and BIC statistics (Table S9). Random effects of predictors did not significantly improve fit and so they were not included in the final model.

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The results of the regression analysis indicate that both child-level characteristics and SES are significant predictors of children's EDI domain scores, as indicated by decreasing deviance, AIC, and BIC statistics across models, as well as significant likelihood ratio tests (supplementary tables 4 through 8).

Year of data collection, province/territory, and the interaction between them were statistically significant for all domains. Age was statistically significant for all domains except physical health & wellbeing. Age was positively associated with language and cognitive development scores, and negatively with emotional maturity, social competence, and communication skills & general knowledge, with the largest effect sizes seen in the latter two domains and the smallest in physical health & wellbeing. Sex was statistically significant for all EDI domains and, on average, girls had higher scores than boys on all domains of the EDI, with the smallest sex differences in language & cognitive development, and largest in emotional maturity. English/French language learners had higher scores than non-learners in emotional maturity (smallest absolute effect) but lower scores in language & cognitive development and communication skills & general knowledge (largest absolute effect). The SES index was a statistically significant predictor of all EDI domains and was consistently positively associated with all domain scores. The smallest association was observed for the emotional maturity scores, and the largest for and language & cognitive development.

***Model Diagnostics and Sensitivity Analyses***

Excluding categorical variables, all VIF statistics were below the cut-off of 10 and ranged from 1.05 and 1.10. Studentized residuals were used to identify influential and outlying observations. The results of the sensitivity analysis excluding cases with absolute studentized residual values greater than 2 are presented in Table S10 through 14. The results from this sensitivity analysis were very similar to the results of the primary analysis.

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## Discussion

The objective of this investigation was to examine the association between neighborhood-level SES and developmental health in children with disabilities (operationally defined as "special needs" designation) at school entry, in order to determine the importance of contextual factors in predicting outcomes in this population. The results indicate that neighborhood-level SES is a consistent and significant predictor of developmental outcomes in this population. An average difference of 0.12 to 0.29 points in EDI domain scores was observed per standard deviation difference in SES, with higher EDI domain scores being observed in higher SES neighborhoods. Neighborhood-level SES had the strongest association with the language & cognitive development domain and the weakest with emotional maturity domain.

### *Consistency with previous studies*

Comparing the magnitude of association between SES and developmental health with previous literature is difficult due to differences in the operationalization of these constructs and differences in analytic methods. Previous studies, mostly conducted with typically developing children,[12] have either explored the direct association between SES and developmental health[8 15-17 45] or investigated mediators of this relationship, including parent/child activities, access to a computer, participation in organized classes and activities, and maternal mental health.[46-48] Most of these studies measured SES at the individual family level and all demonstrated a positive association between social and economic variables and developmental health.

Among the studies done in typically developing populations, five use EDI outcomes, with four including neighborhood-level measures of SES.[8 15 17 49] All studies demonstrated a positive association between SES and the EDI. Webb et al. compared neighborhood effects in typically developing children using four published neighborhood SES indices.[8] Forer et al. examined the same association using the CanNECD index. Both these studies showed that the strength of association between the indices and EDI

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domains varied, depending on the domain and SES index used. Similar to our results, the strongest association was consistently found for the language & cognitive development domain.

The few studies done in children with disabilities also report a positive association between SES and academic and social outcomes.[21-23 50-52] These studies are different from the present investigation in that they only focus on a few high-incidence diagnoses, such as learning disabilities during middle childhood and adolescence and do not measure SES at the neighborhood-level.

***Strengths and limitations***

There are several strengths of this study. First, we used population-level data, which made focusing on children with disabilities that only make up a small proportion of the population possible, while also maximizing external validity and statistical power and minimizing potential selection bias. Second, we focused on early childhood, a time that critically impacts children's long-term academic and social trajectory.[53] Third, we applied a non-categorical approach to childhood disabilities which reflects current thinking in the field of child development and findings that diagnostic categories often do not fully reflect the actual abilities and needs of children.[54-56] Fourth, the EDI has undergone extensive reliability and validity testing, and has been found to be predictive of academic achievement and social functioning throughout early and middle childhood.[26-35] The psychometric performance of the EDI in children with special needs has also been found similar to its performance in typically developing children.[36] Currently, the EDI is the only available indicator of developmental health that allows examination of variability across Canada at a population-level. Finally, the analytic methods used in this investigation appropriately take into account the skewed distribution and nesting of EDI data, which prevents artificially deflated standard errors and hence inappropriate statistically significant findings.

This investigation is also subject to limitations. First, due to the cross-sectional design of this study, causality cannot be established. There is evidence that developmental problems in children may increase parental stress and impact the general socioeconomic wellbeing of families.[57 58] Additionally,



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there is the possibility of self-selection where families with similar experiences may choose to reside within similar neighborhoods. Regardless of causality, or lack thereof, the results of this study indicate that services aimed at young children with disabilities that are particularly accessible in low SES neighborhoods are likely to be most impactful.

Second, we used a very broad definition of disability, which is based on the designation of the child by the education system at kindergarten, and hence, children with disabilities who did not have this designation by the education system were excluded. It is possible that a very small minority of children who were not typically developing but did not have this designation were excluded.

Third, the SES index may not accurately reflect the socioeconomic condition of the neighborhoods in which children were raised. The variables used to construct the SES index come from 2005 and 2006, whereas EDI data were collected between 2004 and 2014. It is possible that changes in neighborhoods or relocation of families could render the SES index less reflective of the true early environment for some groups of children, which may have led to underestimation of the association between SES and developmental outcomes. However, empirical evidence indicates that it is unlikely for neighborhood characteristics to drastically change over time or for families move to neighborhoods which are greatly different from their previous ones.[59] This appears to be confirmed by the remarkable stability of the CanNECD SES Index, the measure used in this study, over the period of five years.[49]

Finally, we were unable to control for family-level SES in the models. Thus, it is not possible to determine whether this association is driven by neighborhood or family characteristics. We were also unable to control for specific diagnoses or severity of disabilities that have undoubted impact on child development. Similar investigation should be extended for smaller subgroups of children who share diagnoses or functional impairments.

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***Implications***

Our findings indicate that the relationship between SES and developmental outcomes also holds for children with disabilities.[8 15-17 45 60] This underscores the potential impact of the early environment of children on their development. Although clinicians often focus on biological factors, such as family history of disabilities and harmful exposures in utero, social influences have commonly been found to be more predictive of long-term developmental and academic outcomes and may be more amenable to change.[45] According to survey data, clinicians are receptive to screening for social determinants of health outside of the purview of clinical care, suggesting that the findings of this investigation are likely to be relevant and acceptable to those in the clinical community.[61] Our findings show that the association between child development and socioeconomic status, which is well-established for typically developing children, also exists for children with disabilities. This highlights the urgency for improving the social and economic context in which children are raised, in addition to targeted interventions delivered at the individual child level. Failure to do so will likely result in further perpetuation of inequities in child development – more so as children with disabilities are already among the most disadvantaged groups globally.[18 62] It remains to be seen whether large-scale policy interventions can help in reducing disparities in this population similarly to other groups.[63]

It is important to consider the findings in context of the availability of support services for children with special needs in Canada prior to school entry. The strategies, programs, and accessibility vary by province/territory, and often within jurisdictions, as municipal and regional health units are often service providers, but generally access is easier for children with a specific diagnosis than for those with unspecified disorders.[55] While there are no detailed studies on the potential association of service availability or magnitude of waiting lists with neighborhood SES per se, there could be at least two pathways to such relation. First, services tend to be located in large urban centres (with likely higher SES overall), where there are more professionals.[64 65] Second, navigation of the care systems, especially for

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preschool children rests largely on the shoulders of parents: the ability to do so effectively is likely associated with their personal and economic resources and where they live. [66 67]

Additional investigations could further strengthen and contextualize these findings. Specifically, establishing the consistency and relative strength of the relationship between SES and developmental outcomes across subgroups of physical, behavioral, and learning disabilities, as well as subgroups based on severity of condition and time of diagnosis, would further untangle the relationship between SES, disabilities, and development, and would be helpful in identifying service provision strategies that are likely to be most successful in improving outcomes.

**Conclusion**

The results from this investigation show neighborhood SES to be significantly associated with the developmental health of children with disabilities at school entry. These findings have implications for policy planning and provision of health and educational service and draw attention to the universality of importance of contextual factors for development of all children.

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**Competing interests:** None.

**Contributions:** DZ, ED, TB, MJ, MG, BF, and MB conceived the study. DZ analyzed and ED provided technical expertise. DZ wrote the first draft of the manuscript and all authors made significant contributions to the manuscript.

**Data sharing statement:** The dataset analyzed in the current study is not publicly available due to multiple jurisdictional privacy restrictions, but it is available at the host institution.

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**Table 1: Population characteristics**

| **Sex** | **N (% of population of children with disabilities)** |
|---|---|
| Female | 8906 (30.2) |
| Male | 20585 (69.7) |
| Missing | 29 (0.1) |
| **Age** | |
| Mean (SD) | 5.79 (0.41) |
| Missing | 114 (0.39) |
| **EFSL Status** | **N (%)** |
| Yes | 3637 (12.3) |
| No | 25402 (86.0) |
| Missing | 481 (1.6) |
| **Province** | **N (%)** |
| Alberta | 2099 (7.1) |
| British Columbia | 5044 (17.1) |
| Manitoba | 2468 (8.4) |
| New Brunswick | 327 (1.1) |
| Newfoundland | 641 (2.2) |
| Nova Scotia | 1083 (3.7) |
| Northwest Territories | 65 (0.2) |
| Ontario | 13198 (44.7) |
| Prince Edward Island | 29 (0.1) |
| Quebec | 3023 (10.2) |
| Saskatchewan | 1440 (4.9) |
| Yukon | 103 (0.3) |
| **Year of data collection** | **N (%)** |
| 2004 | 474 (1.6) |
| 2005 | 2332 (7.9) |
| 2006 | 4304 (14.6) |
| 2007 | 1471 (5.0) |
| 2008 | 1762 (6.0) |
| 2009 | 4786 (16.2) |
| 2010 | 2658 (9.0) |
| 2011 | 3494 (11.8) |
| 2012 | 5140 (17.4) |
| 2013 | 2711 (9.2) |
| 2014 | 388 (1.3) |
| **Mean (SD) EDI domain scores** | |
| PHWB | 7.02 (2.12) |
| SC | 5.71 (2.63) |
| EM | 6.13 (1.99) |
| LCD | 6.18 (3.01) |
| CSGK | 4.37 (3.27) |

PHWB=Physical health & wellbeing; SC=Social competence; EM=Emotional maturity; LCD=Language & cognitive development; CSGK=communication skills & general knowledge

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**Table 2: Neighborhood characteristics (N=2016)**

| **Province** | **Number of neighborhoods (%)** |
|---|---|
| Alberta | 259 (12.8) |
| British Columbia | 298 (14.7) |
| Manitoba | 75 (3.7) |
| New Brunswick | 48 (2.4) |
| Newfoundland | 41 (2.0) |
| Nova Scotia | 57 (2.8) |
| Northwest Territories | 3 (0.1) |
| Ontario | 795 (39.4) |
| Prince Edward Island | 6 (0.3) |
| Quebec | 373 (18.5) |
| Saskatchewan | 55 (2.7) |
| Yukon | 6 (0.3) |
| **Median (IQR) number of children with disabilities in each neighborhood** | 11 (6 – 19) |
| **Median (IQR) number of children in each neighborhood** | 128 (87 – 194) |

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**Table 3: Final Hierarchical Generalized Linear Models (HGLMs) for the Early Development Instrument (EDI)**

| Variables | Physical health & wellbeing (PHWB) | Social competence (SC) | Emotional maturity (EM) | Language & cognitive development (LCD) | Communication skills & general knowledge (CSGK) |
|---|---|---|---|---|---|
| | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) | ß coefficient (95% CIs) |
| **Age** | -0.04 (-0.01 to 0.03) | -0.13 (-0.22 to -0.05) | -0.08 (-0.14 to -0.02) | 0.10 (0.01 to 0.18) | -0.13 (-0.24 to -0.02) |
| **Sex (M=0; F=1)** | 0.14 (0.08 to 0.19) | 0.76 (0.69 to 0.83) | 0.81 (0.76 to 0.86) | 0.13 (0.05 to 0.21) | 0.43 (0.33 to 0.53) |
| **EFSL (no=0; yes=1)** | 0.04 (-0.04 to 0.12) | -0.10 (-0.20 to 0.01) | 0.12 (0.05 to 0.20) | -0.43 (-0.56 to -0.31) | -1.11 (-0.94 to -1.27) |
| **SES z-score** | 0.17 (0.14 to 0.20) | 0.17 (0.13 to 0.21) | 0.12 (0.09 to 0.15) | 0.29 (0.24 to 0.33) | 0.19 (0.14 to 0.24) |

95% CIs=95% confidence intervals; EFSL=English/French as a second language; SES=socioeconomic status

Note that coefficient presented in this table reflect the directionality of the association between variables and untransformed EDI scores.

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**Table S1: Variables included in the Canadian Neighbourhoods and Early Child Development (CanNECD) socioeconomic status (SES) index**

| | |
|---|---|
| **Education** | % with no high school diploma |
| **Language/Immigration** | % not speaking either official language at home |
| **Marital Status** | % separated or divorced |
| **Wealth** | % with investment income, families with children under 6 |
| **High Income** | % with incomes ≥ twice than provincial median, families with children under 6 |
| **Dues** | % with union/association dues, families with children under 6 |
| **Social Capital** | % with charitable donations, families with children under 6 |
| **Poverty** | % with low income, lone parent families with children under 6 |
| **Residential Stability** | % non-migrant movers in the past year |
| **Income Inequality** | Gini Coefficient, lone female families with children under 6 |

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**Table S2: Descriptive characteristics of neighborhoods excluded from analysis (n=40)**

| Province | Number of neighborhoods (%) |
|---|---|
| **Alberta** | 8 (20) |
| **New Brunswick** | 4 (10) |
| **Ontario** | 5 (12.5) |
| **Quebec** | 23 (57.5) |
| **Median (IQR) number of children in each neighbourhood** | 83 (56-141) |
| **Mean (SD) of standardized SES index** | 0.38 (0.88) |

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**Table S3: Descriptive characteristics of population of children with missing Physical Health & Wellbeing (PHWB) scores (n=446)**

| | PHWB | SC | EM | LCD | CSGK |
|---|---|---|---|---|---|
| **Sex** | **N (%)** | | | | |
| Female | 123 (27.6) | 138 (30.5) | 166 (27.7) | 154 (28.4) | 128 (30.4) |
| Male | 318 (71.3) | 311 (68.7) | 429 (71.5) | 384 (70.8) | 289 (68.6) |
| Missing | 5 (1.1) | 4 (0.9) | 5 (0.8) | 4 (0.7) | 4 (1.0) |
| **Age** | | | | | |
| Mean (SD) | 5.78 (0.40) | 5.73 (0.4) | 5.78 (0.4) | 5.76 (0.4) | 5.76 (0.41) |
| Missing | 7 (1.57) | 6 (1.3) | 8 (1.3) | 6 (1.1) | 7 (1.66) |
| **EFSL Status** | **N (%)** | | | | |
| Yes | 61 (13.7) | 61 (13.5) | 76 (12.7) | 77 (14.2) | 59 (14.0) |
| No | 379 (85.0) | 386 (85.2) | 511 (85.2) | 457 (84.3) | 355 (84.3) |
| Missing | 6 (1.3) | 6 (1.3) | 13 (2.2) | 8 (1.5) | 7 (1.7) |
| **Province** | **N (%)** | | | | |
| Alberta | 82 (18.4) | 84 (18.5) | 92 (15.3) | 91 (16.8) | 85 (20.2) |
| British Columbia | 9 (2.0) | 17 (3.8) | 41 (6.8) | 45 (8.3) | 7 (1.7) |
| Manitoba | 122 (27.4) | 117 (25.8) | 131 (21.8) | 121 (22.3) | 113 (26.8) |
| New Brunswick | 1 (0.2) | 1 (0.2) | 4 (0.7) | 1 (0.2) | 0 (0) |
| Newfoundland | 3 (0.7) | 6 (1.3) | 6 (1.0) | 3 (0.6) | 5 (1.2) |
| Nova Scotia | 15 (3.4) | 14 (3.1) | 20 (3.3) | 21 (3.9) | 15 (3.6) |
| Northwest Territories | 1 (0.2) | 1 (0.2) | 2 (0.3) | 1 (0.2) | 1 (0.2) |
| Ontario | 193 (43.3) | 192 (42.4) | 241 (40.2) | 222 (41.0) | 173 (41.1) |
| Prince Edward Island | 0 (0) | 0 (0) | 0 (0) | 1 (0.2) | 0 (0) |
| Quebec | 5 (1.1) | 3 (0.7) | 33 (5.5) | 15 (2.8) | 7 (1.7) |
| Saskatchewan | 8 (1.8) | 13 (2.9) | 19 (3.2) | 14 (2.6) | 10 (2.4) |
| Yukon | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| **Year of data collection** | **N (%)** | | | | |
| 2004 | 3 (0.7) | 3 (0.7) | 7 (1.2) | 3 (0.6) | 2 (0.5) |
| 2005 | 19 (4.3) | 17 (3.8) | 29 (4.8) | 21 (3.9) | 12 (2.9) |
| 2006 | 46 (10.3) | 44 (9.7) | 77 (12.8) | 61 (11.3) | 46 (10.9) |
| 2007 | 26 (5.8) | 23 (5.1) | 39 (6.5) | 32 (5.9) | 21 (5.0) |
| 2008 | 33 (7.4) | 34 (7.5) | 43 (7.2) | 39 (7.2) | 32 (7.6) |
| 2009 | 50 (11.2) | 55 (12.1) | 70 (11.7) | 69 (12.7) | 43 (10.2) |
| 2010 | 51 (11.4) | 48 (10.6) | 57 (9.5) | 58 (10.7) | 43 (10.2) |
| 2011 | 96 (21.5) | 96 (21.2) | 113 (18.8) | 113 (20.8) | 97 (23.0) |
| 2012 | 51 (11.4) | 56 (12.4) | 80 (13.3) | 67 (12.4) | 53 (12.6) |
| 2013 | 71 (15.9) | 74 (16.3) | 84 (14.0) | 79 (14.6) | 72 (17.1) |
| 2014 | 0 (0) | 3 (0.7) | 1 (0.2) | 0 (0) | 0 (0) |
| **Mean (SD) EDI domain scores** | | | | | |
| PHWB | NA | 5.06 (2.17) | 6.70 (2.33) | 6.82 (2.09) | 7.71 (1.96) |
| SC | 5.42 (2.97) | NA | 5.47 (2.54) | 4.78 (2.33) | 5.97 (2.98) |
| EM | 5.90 (2.53) | 5.42 (1.44) | NA | 5.65 (1.89) | 6.31 (1.36) |
| LCD | 5.39 (3.31) | 1.98 (2.38) | 5.51 (3.15) | NA | 6.29 (3.46) |
| CSGK | 3.80 (3.34) | 0.86 (1.91) | 3.77 (3.06) | 2.93 (2.74) | NA |

PHWB=Physical health & wellbeing; SC=Social competence; EM=Emotional maturity; LCD=Language & cognitive development; CSGK=communication skills & general knowledge

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**Table S4: Hierarchical Generalized Linear Model (HGLM) for the Physical Health & Wellbeing (PHWB) main of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | DF | P-value | B coefficient (SE) | F-statistic | DF | P-value | B coefficient (SE) | F-statistic | DF | P-value |
| **Intercept** | 3.98 (0.02) | 47093.34 | 1, 2013 | <0.0001 | 4.75 (1.07) | 19.80 | 1, 2002 | <0.0001 | 4.65 (1.07) | 19.10 | 1, 2002 | <0.0001 |
| **Year (categorical)** | | | | | | 3.95 | 10, 26117 | <0.0001 | | 4.18 | 10, 26116 | <0.0001 |
| **Province (categorical)** | | | | | | 13.94 | 11, 26117 | <0.0001 | | 13.54 | 11, 26116 | <0.0001 |
| **Year*Province** | | | | | | 2.54 | 53, 26117 | <0.0001 | | 2.91 | 53, 26116 | <0.0001 |
| **Age** | | | | | 0.03 (0.03) | 1.04 | 1, 26117 | 0.3089 | 0.04 (0.03) | 1.29 | 1, 26116 | 0.2558 |
| **Sex (M=0; F=1)** | | | | | -0.13 (0.03) | 22.96 | 1, 26117 | <0.0001 | -0.14 (0.03) | 24.11 | 1, 26116 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | -0.02 (0.04) | 0.19 | 1, 26117 | 0.6638 | -0.04 (0.04) | 0.94 | 1, 26116 | 0.3325 |
| **SES z-score** | | | | | | | | | -0.17 (0.02) | 116.76 | 1, 26116 | <0.0001 |
| **Deviance** | 118982.4 | | | | 118334.9 | | | | 118222.1 | | | |
| **AIC** | 118988.4 | | | | 118494.9 | | | | 118384.1 | | | |
| **BIC** | 119005.2 | | | | 118943.5 | | | | 118838.4 | | | |
| **Pearson Chi-Square** | 7394.78 | | | | 7475.81 | | | | 7495.20 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S5: Hierarchical Generalized Linear Model (HGLM) for the Social Competence (SC) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 5.31 (0.02) | 62975.90 | 1, 2014 | <0.0001 | 4.62 (1.26) | 13.47 | 1, 2004 | 0.0003 | 4.46 (1.25) | 12.67 | 1, 2003 | 0.0004 |
| **Year (categorical)** | | | | | | 2.83 | 10, 26106 | 0.0016 | | 2.56 | 10, 26106 | 0.0043 |
| **Province (categorical)** | | | | | | 10.27 | 11, 26106 | <0.0001 | | 10.25 | 11, 26106 | <0.0001 |
| **Year*Province** | | | | | | 2.76 | 53, 26106 | <0.0001 | | 2.76 | 53, 26106 | <0.0001 |
| **Age** | | | | | 0.13 (0.04) | 8.99 | 1, 26106 | 0.0027 | 0.13 (0.04) | 10.12 | 1, 26106 | 0.0015 |
| **Sex (M=0; F=1)** | | | | | -0.75 (0.04) | 439.63 | 1, 26106 | <0.0001 | -0.76 (0.04) | 447.29 | 1, 26106 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | 0.12 (0.06) | 4.82 | 1, 26106 | 0.0284 | 0.10 (0.05) | 3.07 | 1, 26106 | 0.0798 |
| **SES z-score** | | | | | | | | | -0.17 (0.02) | 69.10 | 1, 26106 | <0.0001 |
| **Deviance** | 134806.2 | | | | 134020.8 | | | | 133955.4 | | | |
| **AIC** | 134812.2 | | | | 134180.8 | | | | 134117.4 | | | |
| **BIC** | 134829.0 | | | | 134629.5 | | | | 134571.7 | | | |
| **Pearson Chi-Square** | 6654.52 | | | | 6723.87 | | | | 6736.70 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S6: Hierarchical Generalized Linear Model (HGLM) for the Emotional Maturity (EM) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 4.88 (0.02) | 47093.34 | 1, 2014 | <0.0001 | 4.28 (0.96) | 19.71 | 1, 2003 | <0.0001 | 4.18 (0.95) | 19.00 | 1, 2003 | <0.0001 |
| **Year (categorical)** | | | | | | 2.68 | 10, 25974 | 0.0029 | | 2.42 | 10, 25793 | <0.0001 |
| **Province (categorical)** | | | | | | 9.22 | 11, 25974 | <0.0001 | | 9.04 | 11, 25793 | <0.0001 |
| **Year*Province** | | | | | | 2.12 | 53, 25974 | <0.0001 | | 2.06 | 53, 25793 | <0.0001 |
| **Age** | | | | | 0.08 (0.03) | 6.17 | 1, 25974 | 0.0130 | 0.08 (0.03) | 6.63 | 1, 25793 | 0.0101 |
| **Sex (M=0; F=1)** | | | | | -0.81 (0.03) | 970.94 | 1, 25974 | <0.0001 | -0.81 (0.03) | 969.06 | 1, 25793 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | -0.11 (0.04) | 7.29 | 1, 25974 | 0.0070 | -0.12 (0.04) | 10.01 | 1, 25793 | 0.0016 |
| **SES z-score** | | | | | | | | | -0.12 (0.01) | 65.82 | 1, 25793 | <0.0001 |
| **Deviance** | 119448.7 | | | | 118202.7 | | | | 118136.1 | | | |
| **AIC** | 119454.7 | | | | 118362.7 | | | | 118298.1 | | | |
| **BIC** | 119471.6 | | | | 118811.3 | | | | 118752.3 | | | |
| **Pearson Chi-Square** | 4465.48 | | | | 4421.32 | | | | 4428.30 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S7: Hierarchical Generalized Linear Model (HGLM) for the Language & Cognitive Development (LCD) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 4.82 (0.02) | 37229.70 | 1, 2014 | <0.0001 | 4.36 (1.33) | 10.69 | 1, 2003 | 0.0011 | 4.17 (1.33) | 9.80 | 1, 2003 | 0.0017 |
| **Year (categorical)** | | | | | | 3.78 | 10, 26022 | 0.0029 | | 3.49 | 10, 26021 | <0.0001 |
| **Province (categorical)** | | | | | | 6.32 | 11, 26022 | <0.0001 | | 7.01 | 11, 26021 | <0.0001 |
| **Year*Province** | | | | | | 2.13 | 53, 26022 | <0.0001 | | 2.28 | 53, 26021 | <0.0001 |
| **Age** | | | | | -0.11 (0.04) | 6.34 | 1, 26022 | 0.0118 | -0.10 (0.04) | 5.01 | 1, 26021 | 0.0252 |
| **Sex (M=0; F=1)** | | | | | -0.13 (0.04) | 10.35 | 1, 26022 | 0.0013 | -0.13 (0.04) | 10.42 | 1, 26021 | 0.0013 |
| **EFSL (no=0; yes=1)** | | | | | 0.48 (0.06) | 58.32 | 1, 26022 | <0.0001 | 0.43 (0.06) | 47.13 | 1, 26021 | <0.0001 |
| **SES z-score** | | | | | | | | | -0.29 (0.02) | 160.80 | 1, 26021 | <0.0001 |
| **Deviance** | 135595.0 | | | | 135045.0 | | | | 134891.0 | | | |
| **AIC** | 135601.0 | | | | 135205.0 | | | | 135053.0 | | | |
| **BIC** | 135617.8 | | | | 135653.7 | | | | 135507.3 | | | |
| **Pearson Chi-Square** | 10372.47 | | | | 10458.52 | | | | 10531.822 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S8: Hierarchical Generalized Linear Model (HGLM) for the Communication Skills & General Knowledge (CSGK) Domain of the Early Development Instrument (EDI)**

| Parameter | Model 1 | | | | Model 2 | | | | Model 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value | B coefficient (SE) | F-statistic | Df | P-value |
| **Intercept** | 6.65 (0.03) | 63312.62 | 1, 2014 | <0.0001 | 6.11 (1.78) | 11.76 | 1, 2003 | 0.0006 | 4.65 (1.07) | 19.10 | 1, 2002 | 0.0007 |
| **Year (categorical)** | | | | | | 3.95 | 10, 26141 | 0.0247 | | 1.74 | 10, 26140 | 0.0657 |
| **Province (categorical)** | | | | | | 13.94 | 11, 26141 | <0.0001 | | 5.94 | 11, 26140 | <0.0001 |
| **Year*Province** | | | | | | 2.54 | 53, 26141 | 0.0109 | | 1.51 | 53, 26140 | 0.0094 |
| **Age** | | | | | 0.13 (0.06) | 2.05 | 1, 26141 | 0.0258 | 0.13 (0.05) | 5.19 | 1, 26140 | 0.0227 |
| **Sex (M=0; F=1)** | | | | | -0.42 (0.05) | 7.24 | 1, 26141 | <0.0001 | -0.43 (0.05) | 70.12 | 1, 26140 | <0.0001 |
| **EFSL (no=0; yes=1)** | | | | | 1.15 (0.08) | 1.50 | 1, 26141 | <0.0001 | 1.11 (0.08) | 173.86 | 1, 26140 | <0.0001 |
| **SES z-score** | | | | | | | | | -0.19 (0.02) | 55.05 | 1, 26140 | <0.0001 |
| **Deviance** | 151991.9 | | | | 151438.8 | | | | 151384.1 | | | |
| **AIC** | 151997.9 | | | | 151598.8 | | | | 151544.1 | | | |
| **BIC** | 152014.7 | | | | 152047.5 | | | | 151992.8 | | | |
| **Pearson Chi-Square** | 6272.57 | | | | 6810.50 | | | | 6817.77 | | | |

Note the sign (+/-) of correlation coefficients reflects direction of correlation with transformed EDI domain scores (11 – EDI domain scores).
DF=degrees of freedom; EFSL=English/French as a second language AIC=Akaike Information Criterion; BIC-Bayesian Information Criterion

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**Table S9: Goodness-of-fit of different distributions and link functions for the social competence domain**

| | | Identity link | | | Log link | | |
|---|---|---|---|---|---|---|---|
| **Domain** | **Goodness-of-fit statistics** | **Exponential** | **Gamma** | **Normal** | **Exponential** | **Gamma** | **Normal** |
| **Physical health & wellbeing (PHWB)** | AIC | 134241.6 | 118384.1 | 121141.6 | 134240.4 | 118399.9 | 121147.4 |
| | BIC | 134684.7 | 118838.4 | 121595.8 | 134683.5 | 118854.2 | 121601.6 |
| **Social competence (SC)** | AIC | 150247.6 | 113417.4 | 133234.4 | 150247.5 | 134128.9 | NC |
| | BIC | 150690.7 | 134571.7 | 133688.7 | 150690.6 | 134583.2 | NC |
| **Emotional maturity (EM)** | AIC | 144859.5 | 118298.1 | 116476.9 | 144859.8 | 118310 | NC |
| | BIC | 145302.6 | 118752.3 | 116931.2 | 145302.8 | 118764.3 | NC |
| **Language & cognitive development (LCD)** | AIC | 144457.3 | 135053.0 | 140742 | 144457.1 | 135069.7 | 140754.4 |
| | BIC | 144900.3 | 135507.3 | 141196.3 | 144900.2 | 135524 | 141208.7 |
| **Communication skills & general knowledge (CSGK)** | AIC | 163276.5 | 151544.1 | 146002.4 | 163274.7 | 151539.4 | NC |
| | BIC | 163719.5 | 151992.8 | 146456.7 | 163717.8 | 151988.1 | NC |

AIC=Akaike information criterion; BIC=Bayesian information criterion; NC=not converged

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**Table S10: Hierarchical Generalized Linear Model (HGLM) for the Physical Health & Wellbeing (PHWB) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 687 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 4.70 (1.03) | 20.70 | 1, 1999 | <0.0001 |
| **Year (categorical)** | | 6.03 | 10, 25432 | <0.0001 |
| **Province (categorical)** | | 19.14 | 11, 25432 | <0.0001 |
| **Year*Province** | | 4.14 | 53, 25432 | <0.0001 |
| **Age** | 0.02 (0.03) | 0.63 | 1, 25432 | 0.4265 |
| **Sex (M=0; F=1)** | -0.21 (0.03) | 60.10 | 1, 25432 | <0.0001 |
| **EFSL (no=0; yes=1)** | -0.09 (0.04) | 5.07 | 1, 25432 | 0.0243 |
| **SES z-score** | -0.19 (0.02) | 4.14 | 1, 25432 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S11: Hierarchical Generalized Linear Model (HGLM) for the Social Competence (SC) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 317 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 4.54 (1.24) | 13.47 | 1, 2002 | 0.0003 |
| **Year (categorical)** | | 5.26 | 10, 25790 | <0.0001 |
| **Province (categorical)** | | 14.83 | 11, 25790 | <0.0001 |
| **Year*Province** | | 4.43 | 53, 25790 | <0.0001 |
| **Age** | 0.13 (0.04) | 9.48 | 1, 25790 | 0.0021 |
| **Sex (M=0; F=1)** | -0.94 (0.03) | 736.81 | 1, 25790 | <0.0001 |
| **EFSL (no=0; yes=1)** | 0.07 (0.05) | 1.74 | 1, 25790 | 0.1862 |
| **SES z-score** | -0.18 (0.02) | 86.23 | 1, 25790 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S12: Hierarchical Generalized Linear Model (HGLM) for the Emotional Maturity (EM) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 409 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 3.36 (0.91) | 13.54 | 1, 2001 | 0.0002 |
| **Year (categorical)** | | 3.84 | 10, 25566 | <0.0001 |
| **Province (categorical)** | | 12.32 | 11, 25566 | <0.0001 |
| **Year*Province** | | 3.04 | 53, 25566 | <0.0001 |
| **Age** | 0.10 (0.03) | 10.68 | 1, 25566 | 0.0011 |
| **Sex (M=0; F=1)** | -0.91 (0.03) | 1307.36 | 1, 25566 | <0.0001 |
| **EFSL (no=0; yes=1)** | -0.13 (0.04) | 11.97 | 1, 25566 | 0.0005 |
| **SES z-score** | -0.14 (0.01) | 88.74 | 1, 25566 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S13: Hierarchical Generalized Linear Model (HGLM) for the Language & Cognitive Development (LCD) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 619 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 3.43 (1.27) | 12.11 | 1, 2002 | 0.0005 |
| **Year (categorical)** | | 5.87 | 10, 25403 | <0.0001 |
| **Province (categorical)** | | 13.29 | 11, 25403 | <0.0001 |
| **Year*Province** | | 4.16 | 53, 25403 | <0.0001 |
| **Age** | -0.20 (0.04) | 22.42 | 1, 25403 | <0.0001 |
| **Sex (M=0; F=1)** | -0.23 (0.04) | 36.93 | 1, 25403 | <0.0001 |
| **EFSL (no=0; yes=1)** | 0.50 (0.06) | 67.66 | 1, 25403 | <0.0001 |
| **SES z-score** | -0.39 (0.02) | 278.45 | 1, 25403 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**Table S14: Hierarchical Generalized Linear Model (HGLM) for the Communication Skills & General Knowledge (CSGK) Domain of the Early Development Instrument (EDI) excluding outlying and influential cases (n = 2 excluded)**

| | B coefficient (SE) | F-statistic | Df | P-value |
|---|---|---|---|---|
| **Intercept** | 6.02 (1.78) | 11.49 | 1, 2002 | 0.0007 |
| **Year (categorical)** | | 1.81 | 10, 26139 | 0.0527 |
| **Province (categorical)** | | 7.35 | 11, 26139 | <0.0001 |
| **Year*Province** | | 1.63 | 53, 26139 | 0.0027 |
| **Age** | 0.13 (0.06) | 5.09 | 1, 26139 | 0.0241 |
| **Sex (M=0; F=1)** | -0.43 (0.05) | 71.08 | 1, 26139 | <0.0001 |
| **EFSL (no=0; yes=1)** | 1.11 (0.08) | 173.83 | 1, 26139 | <0.0001 |
| **SES z-score** | -0.19 (0.03) | 54.80 | 1, 26139 | <0.0001 |

EFSL=English/French as a second language; Df=degrees of freedom

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 2 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4-5 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5-6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 5 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5-6 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6 |
| Bias | 9 | Describe any efforts to address potential sources of bias | NA |
| Study size | 10 | Explain how the study size was arrived at | NA; population-level data |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 6-7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 6-7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | NA |
| | | (*c*) Explain how missing data were addressed | 7 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | 6 |
| | | (*e*) Describe any sensitivity analyses | 7 |

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| | | | |
|---|---|---|---|
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | NA; population-level database. |
| | | (b) Give reasons for non-participation at each stage | NA; population-level database. |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Tables 1 and 2 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Table S3 |
| Outcome data | 15* | Report numbers of outcome events or summary measures | |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Table 3<br><br>Although unadjusted estimates are not presented, VIF statistics were very low, indicating that predictor variables were not correlated with one another. When there is little to no correlation between predictor variables, unadjusted and adjusted effect estimates are likely very similar. |
| | | (*b*) Report category boundaries when continuous variables were categorized | NA |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 9 |

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| | | | |
|---|---|---|---|
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 9 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 11-12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 10-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 12-13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 13 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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