SPECIAL NEEDS PREVALENCE & CHILDREN'S DEVELOPMENTAL HEALTH

KINDERGARTEN PREVALENCE OF CHILDREN WITH SPECIAL NEEDS IN ONTARIO AND DEVELOPMENTAL HEALTH OUTCOMES AT SCHOOL ENTRY AND GRADE 3

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Abstract

Background: One in every nine school-age children in Ontario has special needs (SN) as a result of developmental disorders, however, the distribution of SN is unequal among schools. This prompted a group level exploration of the developmental health outcomes of typically developing children in schools with SN children.

Methods: This study uses data from the Early Development Instrument (EDI; kindergarten measure of child development), administered in Ontario between 2010-2012, and neighbourhood-level socioeconomic status (SES) from the 2006 Canadian Census to examine associations between school SN prevalence and typically developing children's development. Relationships between school SN prevalence and developmental health in those schools were explored in Grade 3 using Education, Quality and Accountability Office (EQAO) tests.

Findings: Kindergarten multivariable regression model showed that school SN prevalence was associated with school level kindergarten vulnerability rates after controlling for SES and demographic factors. However, school SN prevalence was not a significant predictor of school performance in Grade 3 reading, writing and math test scores. Our exploration revealed that school kindergarten vulnerability rate, which was itself associated with the school prevalence of children with SN, was a stronger predictor of school Grade 3 academic outcomes than school SN prevalence after controlling for demographic and SES factors.

Conclusions: This study provides a snapshot of population level inequalities in child health outcomes by demonstrating associations between school SN prevalence and kindergarten vulnerability, and kindergarten vulnerability and Grade 3 achievement. These findings further emphasize the importance of adequate early intervention programs in schools, and appropriate resource allocation for the health outcomes of typically developing children.

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1.0 INTRODUCTION

Scientific evidence has widely demonstrated the important role of a smooth transition from preschool to formal schooling in a child's later academic and social success (Janus, Lefort, Cameron, & Kopechanski, 2007). School entry constitutes a significant milestone for children, one that forms the foundation of their social, emotional, and behavioral learning in future years. Not surprisingly, a child's ability to transition to school successfully is also associated with their readiness to learn as positive transition experiences are associated with favourable academic and social outcomes (Berlin, Dunning, & Dodge, 2011). While transition to school can be a difficult adjustment period for both typically developing children and those with specific challenges, those who have one or more physical, social, or behavioral disabilities experience increased hardship when adjusting to school, and struggle to meet age-appropriate learning expectations (Margetts, 2002). Children with specific developmental challenges, also referred to as children with special needs, often experience chronic emotional, social, mental, physical, and behavioral conditions that make learning difficult (Doucet, Pooran, Briggs, Lee, & Strapleton, 2015). The prevalence of children with special needs is steadily increasing in Canada, and currently one in every nine school age children has special needs. While transition to school is a crucial milestone for any child, it is even more important for children with special needs. Children with special needs often require additional support for positive school experiences that allow them to take advantage of school activities and learning (Bowes, Harrison, Sweller, Taylor, & Neilsen-Hewett, 2009).

Every year, many kindergarten students have special needs requirements for which they need further accommodation in the classroom setting (Doucet et al., 2015; *Special Education in Ontario: Kindergarten to Grade 12*, 2017). However, families of children with special needs report a lack of support in obtaining adequate accommodation for their child (McIntyre, Eckert, Fiese, DiGennaro, & Wildenger, 2007). Research has also demonstrated that special needs status may be associated with

poor social and environmental factors that make special needs service provision and support largely inaccessible for children. These factors often include individual level determinants such as family structure, child and parent health, parental involvement in child's education, as well as population characteristics such as neighbourhood socioeconomic status (SES) and residential mobility (Beauvais & Jenson, 2003; Janus & Duku, 2007; Spencer, Blackburn, & Read, 2015).

Here, I will explore current research on the population level determinants of child health outcomes. First, I will start by providing insight into the theoretical framework that forms the basis of this research. Then, I will delve deeper into prevalence and factors associated with special needs, importance of early intervention, and the contribution of social & environmental determinants on a child's developmental health. I will also discuss educational accommodations for children with special needs in Ontario, and finally, introduce the research objectives of the study.

1.1. Theoretical Framework

The bioecological model of human development by Urie Bronfrenbrenner (2006) posits that child development is a process that extends beyond the home environment. Bronfrenbrenner hypothesized that individuals interacted with their environments through four ecological systems: microsystem, mesosystem, exosystem, and macrosystem. The microsystem represents a child's most immediate interactions (i.e. with their parents, siblings, or school environment), and the mesosystem refers to the interactions between the child's school environment and neighbourhood context. This framework addresses how a child's home and school environment might influence them. Thus, the strength of this theory lies not only in its ability to acknowledge interactions both within individuals and between individuals and systems (i.e. parents, school environment) but also interactions between multiple systems (Bronfenbrenner & Morris, 2006). Considering that the geographical location of one's residence may greatly determine accessibility of resources, social hierarchies, and give rise to disparate health outcomes, this study uses the above framework to explore the mediating effects of neighbourhood in the relationship between the distribution of special needs and child development.

1.2 Children with Special Needs

A child's early years represent an important period in life that lays the foundation for future learning and developmental growth. In Ontario, a child with special needs is considered to have one or more exceptionalities, which refer to patterns of strengths of needs that are unique to their learning (*Special Education in Ontario: Kindergarten to Grade 12*, 2017; Zegarac, Drewett, & Swan, 2008). Exposing children to positive stimuli and limiting exposure to negative experiences is beneficial to ongoing development (Shore, 1997). Since the malleability of the brain's neural circuitry decreases over time, the impact of early negative experiences becomes increasingly difficult to alter with age (Shore, 1997). The importance of positive early experiences is even more important for children with

special needs and disabilities (Stein & Jessop, 1982). Literature has increasingly demonstrated that children with special needs may belong to various different categories (Janus et al., 2007; Stein & Jessop, 1982). The prevalence of various disorder diagnoses may be very different across environments such as schools, neighbourhoods and provinces, and requires the use of population level data to further explore these associations. Consequently, this study defines special needs children based on the supports they need as opposed to their formal disability diagnosis.

1.3 Prevalence of Special Needs

In 2010, the prevalence of children with special needs in Ontario was 3.7% in kindergarten (*EDI in Ontario*, 2017). One study in the United States reported the prevalence of special needs to be higher amongst Non-Hispanic white, black, and other racial/ethnic groups compared to their Hispanic counterparts (Dyck, Kogan, McPherson, Weissman, & Newacheck, 2004). This study consisted of families of 38, 866 children <18 years of age and they were interviewed to further ascertain their demographic and special needs characteristics. Furthermore, children from families living in poverty may also be more likely to be screened for special needs due to pre-conceived notions about socioeconomic disadvantage inevitably resulting in poor health and learning outcomes. While those living in disadvantaged neighbourhoods and social situations have been found to be more likely to have a diagnosis of special needs by some, others have shown that children in kindergarten, Grades 4 and 7 in these neighbourhoods are just as likely to not be identified due to a lack of resources and services (Maggi, Hertzman, Kohen, & D'Angiulli, 2004).

1.4 Factors Contributing to Special Needs Prevalence

Children may be diagnosed as having special needs due to biological factors such as genetic anomalies, birth defects, or injuries (Doucet et al., 2015), but also as a result of environmental factors such as family structure, acute or chronic exposure to stressful experiences, including maltreatment and neglect, parenting habits, and neighborhood characteristics (Brinkman et al., 2012; Maggi et al., 2004).

1.4.1. Population-Level Characteristics

A growing body of literature has suggested a positive relationship between favourable neighbourhood characteristics and better health outcomes in individuals (Beauvais & Jenson, 2003; Minh, Muhajarine, Janus, Brownell, & Guhn, 2017). Prevalence of childhood disability in particular has been shown to be associated with neighbourhood characteristics such as socioeconomic disadvantage (Beauvais & Jenson, 2003). The idea of neighbourhoods playing a role in health outcomes arose due to concerns regarding social inequalities and disadvantaged groups being unable to access adequate resources and support themselves. Several neighbourhood characteristics, specifically those related to a family's socioeconomic status, are associated with health outcomes in children with SN. These include but are not limited to family income, parental education level, occupation/employment, and immigration/mobility (Beauvais & Jenson, 2003; Schneiders et al., 2003).

It has been widely established that the developmental health of young children is influenced by the socioeconomic conditions of their surroundings and the environment in which they are raised (Duncan, Brooks-Gunn, & Klebanov, 1994; Schneiders et al., 2003). Health disparities, such as access to resources and healthcare services, exposure to toxins, physical activity and access to nutrition are often strongly associated with SES. Furthermore, both family and neighbourhood level SES have been associated with childhood injury rates (Brownell et al., 2010), childhood hospitalizations (Jutte et al., 2010), childhood anxiety, depression and more (Essex et al., 2006). Particularly, low level of parental education, income, employment, and high mobility are all associated with child development (Busacker & Kasehagen, 2012; Daly, Duncan, McDonough, & Williams, 2002; Flores, Bauchner, Feinstein, & Nguyen, 1999).

Family income, defined as the flow of economic resources over a period of time, is associated with health-seeking behaviours, access to resources and overall lifestyle (Séguin et al., 2005). Children born into low-income families have a higher risk of experiencing acute health problems, developmental

delay, and higher risk of hospitalizations compared to children born into well-off families due to these families having further knowledge or access to more resources.

Similarly, parental education level, expressed as percent of a population with and without post-secondary education is also a commonly used and cited measure of SES at a neighbourhood level. Many researchers argue that education is the most important indicator of SES because it tends to impact other important SES indicators such as occupation and income (Flores et al., 1999). For instance, a person with higher education may have developed better information processing and critical thinking skills that enable them to more efficiently navigate bureaucracies and institutions, and advocate for the resources they need. These individuals may also be more likely to exhibit and internalize better health-promoting behaviours and lifestyles, as well as have better work and economic conditions. When these health-promoting behaviours are practiced in a family setting, they are often transferred to the children in the family. Limitations to using parental education as a SES measure include the fact that economic returns may be slightly different across racial and ethnic backgrounds despite similar years of education, and that the social meaning behind education is largely dependent on cultures and time periods (Shavers, 2007). However, despite these limitations, education still acts as a strong SES indicator as it is easy to measure, excludes few members of the population (increasing predictive power) and is less likely to be influenced by other factors as it tends to be fairly stable beyond early adulthood (Shavers, 2007). Finally, limitations associated with individual SES measures can be eliminated by obtaining an aggregate of all individuals' neighbourhood data through census or survey methods. This is because aggregating data to a population level not only accounts for individuals in the population but also allows results to be applicable to public health policy and epidemiology (Pollet, Stulp, Henzi, & Barrett, 2015).

Occupation is often used to assess health disparities because of its role in positioning individuals within the social structure thereby defining access to resources and exposure to various risks (Daly et al., 2002). Therefore, employment improves the health of populations similar to how

healthy and stable individuals are able to maintain employment. As such, occupation provides a reliable measure of SES because it is less volatile than income (Shavers, 2007). Additionally, occupation may help to reduce the income disparity that occurs when individuals first immigrate to a country, as high earning professionals may not have the licenses or certifications to immediately find work and have a salary in the new country. This is especially important if a child in the family has developmental disorders, as the unfamiliarity associated with the new environment could decrease the types of services and resources the family known to the family.

Residential mobility has also been shown to be significant contributor to child development outcomes (Hutchings et al., 2013; Jelleyman & Spencer, 2008; Webb et al., 2017). Moving from one's home and changes in geographic location are often associated with loss of employment, onset of mental illnesses, and increased stress levels even in adults. The breakdown of social networks and movement away from familiar environments can result in various adjustment challenges in children (Jelleyman & Spencer, 2008). For instance, the effects of moving in younger children can be behavioural in nature, such as changes in daily appetite, increased shyness or aggression, and an increase in perceived attachment to caregiver (Hutchings et al., 2013). In older children however, the effects may be biological, such as changes in sleeping patterns and concentration with a marked decrease in educational achievement in school. Therefore, frequent residential and school mobility are not only associated with poor health outcomes but can also contribute to lower educational achievement. Residential mobility interacts at both individual and aggregate levels in complex ways that are associated with negative developmental outcomes in both young and old children (Jelleyman & Spencer, 2008). As such, it could be strong predictor of SES in this particular study given its relationship to early developmental health outcomes as well as its contribution to educational achievement, the two outcomes of interest in this study. Particularly, examining mobility at an aggregate level will allow us to explore population level inequalities that would otherwise not be possible using measures of individual mobility.

1.5 Barriers to Special Needs Service Provision

Parents and families often feel overwhelmed trying to access resources for children with special needs due to a lack of support from school personnel as well as limited emphasis on quality transition from daycare to formal schooling (Siddiqua & Janus, 2017). All provinces, with the exception of British Columbia, provide special needs care and support through multiple ministries, resulting in fragmented service provision (Doucet et al., 2015; Kohen, Uppal, Khan, & Visentin, 2010). In contrast, British Columbia has introduced a standardized, single-service delivery model that uses a family-centered approach to determine the type and level of support required by the child and family. The non-inclusive nature of services in other provinces makes it difficult to support special needs children holistically. Finally, educational policies surrounding specialized vs. inclusive special needs models not only vary across provinces, but also across schools and school boards, which further adds to the difficulties associated with understanding and seeking special needs services (Kohen et al., 2010)

1.6 Importance of Early Childhood Intervention for Child Health Outcomes

High quality intervention programs have been shown to reduce the occurrence of future problems associated with learning, behavior, and overall health outcomes in children with special needs (Shonkoff & Meisels, 1990). Positive effects of interventions delivered during a child's early years as opposed to later into their development have a higher likelihood of being sustained into their future. Targeted, early, and comprehensive interventions for children with special needs can drastically improve their developmental trajectories. Research has demonstrated that developmental decline among children with special needs can be reduced if not completely avoided with early intervention (Guralnick, 2005). These researchers conducted several systematic reviews suggesting that individuals with developmental and intellectual disabilities experienced significant improvements after participating in early intervention programs, further emphasizing the importance of such interventions.

1.7 Impact of Social and Environmental Determinants on Health Outcomes

Social epidemiologists have long theorized the impact of social determinants of health on an individual's well-being (Currie et al., 2009; Galster, 2012). These determinants, exhibited through the distribution of social and environmental resources in a neighborhood are also significant contributors of childhood developmental outcomes. For example, a neighborhood with high poverty (low neighbourhood SES) may be situated further away from essential early intervention services, thereby limiting the type of care and support received by special needs children living in this neighborhood (Galster, 2012). Studies postulate that social, economic, and cultural characteristics of neighbourhoods may provide a foundation for children's long-term development (Solar & Irwin, 2010). The differences in socioeconomic determinants between neighbourhoods further perpetuate social inequalities and hierarchies, thereby negatively affecting a child's developmental trajectory and potentially creating barriers in accessibility to resources and essential services.

1.8. Special Needs Education in Ontario

1.8.1. Provision and Funding of Special Education in Ontario

In the current curriculum, students with special needs are referred to as "exceptional pupils" who have unique behavioural, communication, and intellectual characteristics that require placement in a special educational program (*Special Education in Ontario: Kindergarten to Grade 12*, 2017). While the sample in this study came from the years 2009/10-2011/12, the processes and identification procedures were the same. Upon undergoing an extensive review of their skills, students with special needs are placed in a special education program that is based on and modified by assessment and evaluation according to an individualized set of objectives. This is conducted by the Identification, Placement, and Review Committee (IPRC), but this process often does not happen until Grade 1. Individuals in the IPRC collectively not only decide if a child is an exceptional pupil, but they also

identify the child's areas of exceptionality accordingly to guidelines set out by the Ministry of Education (*Special Education in Ontario: Kindergarten to Grade 12*, 2017) . These objectives and individualized educational standards make up the child's Individual Education Plan (IEP) and must be reviewed once every year. The IEP includes a detailed description of the student's strengths and needs, an outline of the special education programs and services the student will be receiving, methods of evaluation as well as a transition plan explaining specific goals, and individuals who are accountable and timelines for these objectives (*Special Education in Ontario: Kindergarten to Grade 12*, 2017).

The Ministry of Education provides funding to school boards for students with special needs through the Special Education Grant (SEG) (*Special Education in Ontario: Kindergarten to Grade 12*, 2017). This occurs in addition to the foundation grants, which is the basic level of funding for each student regardless of special needs. These grants are determined based on student enrolment and the specific needs of the students in each board, which are then allocated to schools. Individual schools are also responsible for ensuring that proper and trained staff are hired to teach their special educational services (*Special Education in Ontario: Kindergarten to Grade 12*, 2017).

1.9 Current Study

A positive transition to school, which is associated with favourable social and academic outcomes, holds significant importance for concurrent and future developmental growth (Berlin et al., 2011). This transition is even more challenging for individuals with special needs due to the added stressors of overcoming other transitional barriers at school entry. Impact of negative experiences becomes increasingly difficult to overcome in later life, suggesting that adequate and timely supports are crucial in determining social and behavioural success (Guralnick, 2005). Moreover, there is a wide variation between special needs services, policies and funding across schools and school boards, which may make it difficult to provide children with individualized and comprehensive supports (Kohen et

al., 2010; *Special Education in Ontario: Kindergarten to Grade 12*, 2017). This is further compounded by the impact of low SES neighbourhoods on one's social mobility, thereby limiting access to resources (Beauvais & Jenson, 2003; Minh et al., 2017). While difficult to do, providing adequate support and resources to children is not impossible, and healthcare professionals and school administrators should strive to even the playing field for all children. Considering the current state of knowledge on neighbourhood effects and variations in support levels among schools, it is important to explore the association between school-level prevalence of children with special needs (SN) and developmental health outcomes of typically developing children at the school-level. For brevity, school-level prevalence of children with SN will henceforth be referred to as *school SN prevalence*.

1.10 Research Questions

This study will address the following research questions:

1a. What is the prevalence of children with SN across schools in Ontario?

1b. Are there any significant associations between the prevalence of SN across schools in Ontario and the developmental health of kindergarten children in these schools?

2. Are there any significant associations between the prevalence of SN across schools in Ontario and the rates of developmental health outcomes of kindergarten children in these schools, after accounting for socioeconomic status (SES) factors?

3. Are there any significant associations between the prevalence of SN across schools in Ontario and long-term rates of developmental health of children (measured by academic achievement) in Grade 3, after accounting for SES factors?

It is important to note that the above research objectives aim to explore the developmental health outcomes of typically developing children at the school level.

1.11 Hypotheses

Until now, some studies have suggested that children in schools with a higher proportion of children with SN perform poorly academically and socially due to the lack of targeted and individualized attention towards each child's needs. Reasons cited for this include fewer resources for each child such as equipment, educational materials, teaching personnel, and less time allocated for support in learning (Dupere, Leventhal, Crosnoe, & Dion, 2010; Maggi et al., 2004). In contrast, some studies have also suggested that developmental outcomes for children with SN may actually be more favourable in schools with a higher proportion of children with developmental disabilities, citing it as a protective factor (Msall, Avery, Msall, & Hogan, 2007). Schools with a higher proportion of children with SN are likely more aware of SN resources in the community that may be helpful to parents seeking additional support. Furthermore, parents may also find it beneficial to interact with other parents whose children have developmental disabilities (Liu, King, & Bearman, 2010; Mazumdar, Winter, Liu, & Bearman, 2013). This can facilitate the exchange of vital resources and create an open line of communication between parents experiencing similar challenges in obtaining support for their children with SN. However, it is important to note that the above studies examined developmental outcomes on an individual level and not a population level. This study aims to explore the association between SN prevalence and childhood developmental outcomes at a population level. Therefore, the hypotheses are as follows:

1. There will be significant variation in the prevalence of children with SN across schools in Ontario in kindergarten.
2. There will be no significant associations between the prevalence of children with SN across schools in Ontario and the rates of developmental health outcomes of kindergarten children in these schools, after accounting for SES factors at the school-level.
3. Furthermore, there will be no significant associations between the kindergarten prevalence of children with SN across schools and the long-term rates of developmental health outcomes as

measured by academic achievement in Grade 3, also after accounting for SES factors at the school-level.

2.0 METHOD

2.1 Data Sources and Sampling

The data used in this study came from three sources: the Early Development Instrument (EDI), the 2006 Canadian Census, and Grade 3 Education Quality Accountability Office (EQAO) provincial test scores.

The EDI is an assessment of children's developmental health, completed by teachers in the second half of the kindergarten year, defined as the school year immediately prior to Grade 1 (Janus & Offord, 2007). Particularly, this study used data collected during Cycle III of the EDI implementation in Ontario, which occurred in the 2009/10, 2010/11 and 2011/12 academic years. Long-term development of children in schools with EDIs completed during these years was also examined in Grade 3 using provincial EQAO standardized test scores in reading, writing and mathematics ("Everything you need to know about EQAO: Elementary assessments," 2018). Specifically, these children wrote the Grade 3 tests during the 2012/13, 2013/14, 2014/15 academic years. The final source of data was obtained from the 2006 Canadian census for the purposes of estimating children's SES. The 2006 census was used to estimate children's SES as the sample children in Cycle III of the EDI were born between 2004-2006.

2.1.1 Study Design

This was a retrospective cohort study that used data from the EDI to assess children's developmental health outcomes in kindergarten across validated childhood developmental domains. It also included a longitudinal component to further explore whether kindergarten vulnerability was associated with academic achievement in elementary years.

2.1.2 Study Population

Since the research objectives in this study addressed SN prevalence, the initial dataset included all children with completed Cycle III EDI. In total, there were 119,154 children without SN and 4,834 children with SN in Cycle III of the EDI who had no missing data and were valid for inclusion into subsequent analysis.

2.1.3 Selection Criteria

EDI: Children with completed EDIs were valid for inclusion for the study if 1) they had been in class for at least one month, 2) they were in senior kindergarten at the time of EDI completion and 3) less than 25% of the items on the child's EDI were missing.

EQAO: Data of all children in Ontario whose information was provided to the Ministry of Education for writing the Reading, Writing and Math tests between 2013-2015.

2.1.4 Primary Predictor—School SN Prevalence

A growing body of literature suggests the importance and effectiveness of using clustered and group level data to not only understand disease mechanisms and enhance patient care, but to also improve public health and policy (Daly, 2002). In the context of the current study, analyses were conducted using schools as the unit of analysis. School SN prevalence was calculated using the number of children with SN at each school, which was divided by total number of children in kindergarten in the school to obtain a proportion.

2.1.5 Demographic Characteristics

Demographic information was collected for all children within the EDI questionnaire, including information on child's age (calculated as the difference between child's date of birth and date of EDI completion), child's sex (female, male), English/French as a Second Language (EFSL) status (yes or no), school attended, SN status (yes or no), child's first language (multiple options of language), ability

of child to communicate in first language (yes or no), postal code of residence, and postal code of school.

2.2 Concurrent Outcome Measures

2.2.1 Kindergarten Measure: Early Development Instrument (EDI)

The EDI is a 103-item teacher-completed questionnaire that assesses children's development in kindergarten across five developmental domains: Physical Health and Wellbeing (PHWB), Social Competence (SC), Emotional Maturity (EM), Language and Cognitive Development (LC), and Communication Skills and General Knowledge (CG) (Janus & Offord, 2007). It also includes information on a child's SN status, early childhood health disorders and other functional impairments on the EDI, as well as a number of demographic variables such as the child's date of birth, sex, EFSL status, French immersion, first language, ability to communicate adequately in first language and whether the child is repeating their current grade. In order to standardize the completion of the EDI, teachers were provided training and a Guide by the EDI team at McMaster University. Teachers had a comprehensive guide and were asked to base their assessment of children's behavior, strengths and challenges in the classroom in each of the five domains. For SN status, teachers were asked to answer whether a child was identified as having SN based on whether they needed specific assistance and preventative/ corrective measures due to behavioral/developmental disorders, according to the school board and Ministry of Education regulations (Janus, Zeraatkar, Duku, & Bennett, 2018).

2.2.2 Validity of the EDI

The EDI's aim is to facilitate population level measurement of children's developmental health and school readiness that not only allows aggregate reporting of children's well-being in schools and communities but also enables evidence-based decision making from a policy and jurisdiction standpoint. Teachers complete the EDI in the second half of the kindergarten school year to give them the opportunity to get to know the students in their class well.

Items in the EDI were derived from a combination of existing instruments, focus groups as well as informant interviews (Streiner, Norman, & Cairney, 2015). Validation studies were carried out for five developmentally important domains: Physical Health and Well-Being, Social Competence, Emotional Maturity, Language and Cognitive Development, Communication Skills and General Knowledge (Doherty, 1997; Kagan, 1992). In addition to the developmental domains, there are three sections of the EDI, which cover children's special skills, special problems and aspects of the pre-kindergarten history. An overview of sample questions across all five EDI domains as well as the total number of items in each domain is provided in Table 1.

Table 1: EDI domains with sample questions

Domain	Sample Question
Physical Health & Well-Being (13 items)	Would you say that this child is well coordinated (moves without running into things or tripping over things)?
Social Competence (26 items)	Would you say that this child is able to follow one-step instructions?
Emotional Maturity (28 items)	Would you say that this child comforts a child who is crying or upset?
Language & Cognitive Development (26 items)	Would you say that this child is able to read simple words?
Communication Skills & General Knowledge (8 items)	How would you rate this child's ability to tell a story?

Overall results of the validation studies revealed that the EDI's psychometric properties were acceptable for the measurement of children's early development and subsequent academic achievement (Janus & Offord, 2007). Internal consistency of the EDI domains was between 0.84-0.96, with moderate (0.53) to high (0.80) inter-rater reliability correlations. Test-retest correlations were also high (0.82-0.94) and parent-teacher agreements on the EDI were moderate (0.36-0.64) (Janus & Duku,

2007). The EDI is not intended for a diagnostic use and therefore has not been validated for this capacity.

2.2.3 Special needs status

Based on the report *Special Education in Ontario* mentioned earlier in this paper, a child with SN is defined as an exceptional pupil, whose behavioural, communicational, intellectual, physical or multiple exceptionalities are such that they are considered to need placement in a special education program. These definitions are the same as those used during the years 2009/10, 2010/11, and 2011/12. Special education programs refer to a tailored and modified form of assessment and evaluation that contains special objectives and outline of educational services that meets the needs of the child. Special educational services refer to materials required to successfully implement special educational programs, and may range from facilities and resources to support personnel and equipment (*Special Education in Ontario: Kindergarten to Grade 12*, 2017). In this study, children were considered to have SN if they were reported as such on the EDI in kindergarten by teachers (concurrent outcome), or if they had an IEP in Grade 3 (long-term outcome). However, SEN identification in Grade 3 was only used for correlation purposes in this study.

2.2.4 Domain Scores

Domain scores are calculated taking into account missing answers in the EDI. Item scores ranged from 0 (lowest score) to 10 (highest score). Domain scores were calculated by obtaining an average of the valid item responses on the individual items that contributed to each domain. Higher scores represented more favourable outcomes in the respective domain.

2.2.5 Vulnerability

Children on the EDI are classified as vulnerable, at risk or on track for their development. Individuals who scored below the lowest 10^{th} percentile were classified as vulnerable in the respective

domain(s) (Janus & Duku, 2007). These percentile cutoffs were established using the Ontario baseline EDI population collected in school years 2003/4, 2004/5, and 2005/6. Establishing this cutoff facilitated population level estimates of all children who had developmental vulnerabilities at school, and also provided a starting point for monitoring and evaluating children's future development across communities in Canada. The cutoffs are based on the developmental health of typically developing children only.

2.3 Long-Term Outcome Measures

2.3.1 Grade 3 measures

An estimate of children's long-term achievement was obtained using Grade 3 provincial EQAO test scores on reading, writing and math at the school level. These assessments are completed by children and test their knowledge of reading, writing and mathematics. Scores on these tests range from level 1 to 4 where scoring at level 3 or higher indicates that the child meets provincial standards. Poor academic achievement was defined as scoring at level 1 and 2 as this falls below the provincial standard.

2.3.2 Special Educational Needs (SEN)

For our study, the presence of an Individualized Education Plan (IEP) in Grade 3 was used as an indicator of SEN. IEPs are often created by a group of educators who comprise the Identification, Placement, and Review Committee (IPRC) at the child's school, and help children and their families to identify strengths and challenges faced in the classroom (*Special Education in Ontario: Kindergarten to Grade 12*, 2017). It is important to note that children who have not been formally identified as having SEN also qualify to have their learning outcomes reviewed by the IPRC for the development of an IEP. Therefore, IEPs are not exclusive to children with identified SN. The process of creating IEPs begins in Grade 1.

2.4 Socioeconomic Status (SES)

All participants' individual and school postal codes were matched to 2006 census variables to obtain measures of SES. The 2006 census year was chosen as the closest to the birth years of the children in Cycle III of the EDI (collected between 2010-2012), which was between 2004-2006. The census variables used in this study were occupation (percent employed), education (percent with post-secondary education), mobility (percent non-movers) and income (percent above median income) (Appendix A). These four variables were chosen for consistency with several SES indices as well as their reliability for estimating family SES (Webb et al., 2017). All the variables were obtained from Statistics Canada through *Computing in the Humanities and Social Sciences (CHASS)* at the dissemination area (DA) level, which refers to a relatively small geographic unit consisting of 400-700 people. Data were obtained at the DA level as a proxy for individual family SES. A postal code conversion file (PCCF) was also obtained from Statistics Canada to enable DA to postal code matching to data on the EDI (*Postal Codes Conversion File (PCCF) Reference Guide*, 2011).

2.4.1 Measures of school neighbourhood level SES and Child Health

Four indicators of SES were used in this study: employment status, parental education level, mobility, and income level. Employment status was characterized by those 15 years or over with formal employment as reported in the census (*Statistics Canada 2006 Census*, 2010). Parental education was characterized as total population 15 to 24 years of age who had a University certificate, diploma/degree or higher at time of census. Mobility was defined as mobility status 1 year ago. Finally, median income in dollars was used as the reference for calculating DA's that had above median household income (more in Appendix A).

Employment status was determined by taking the percent employment rate of parents at a school DA level. This was calculated by dividing the total number of individuals employed by the total number of individuals who completed the census (with and without employment) and multiplying by

one hundred percent. Both parental education level and mobility were calculated in the same way by dividing the number of individuals with post-secondary education and number of individuals who moved by the total number of individuals who completed the census in each respective category. Percentages were obtained by multiplying the final values by one hundred percent. Finally, income was obtained from the median household income at the DA level, and proportion of those above median income was used for the analytic models.

2.4.2 Neighbourhood SES

Socioeconomic data were obtained through the University of Toronto's "Computing in the Humanities and Social Sciences" Census Analyzer website (*Statistics Canada 2006 Census,* 2010). The variables were obtained from the 2006 Canadian Census at the DA level. In order to match two different datasets, a common variable must be present in both, specifically in the same format (either numeric or string) and length. The common variables used for merging the SES and EDI datasets were postal codes associated with the DA in the SES dataset and postal codes of the individual children in the EDI dataset. Since the DA level SES dataset did not include postal codes, in order to match the data, the postal code conversion file (PCCF) was obtained from CHASS, which included a common variable between the SES and EDI datasets, DA ID. First, the PCCF was merged with the SES dataset on the common variable DA ID using a one-to-one merge procedure. A one-to-one merge was sufficient in this case because the SES dataset variables were reported at the DA level (i.e. there were no duplicate DA's) and the PCCF also listed the DA IDs with no duplicates.

2.4.3 Individual Aggregate vs. School Neighbourhood SES

With the merged PCCF and SES datasets, the next step was to match the combined dataset to the Cycle III EDI dataset using a common variable such as postal codes. Specifically, this was a one-to-many merge as several individuals had the same DA level postal code. However, the Cycle III EDI dataset contained two types of postal codes: each child's residential postal code and the postal code of

the school the child was attending. Here, we faced a methodological question: at which level of aggregation did SES explain most variance in children's vulnerability using school as a unit of analysis? We used both individual aggregate SES and school neighbourhood SES. Using the individual aggregate SES allowed us to incorporate the child's home SES factors, which could potentially have more explanatory power, but was also methodologically intensive. While using the school neighbourhood SES was a more straightforward and intuitive method, it excluded individual children's home SES contribution, if they did not live in the same DA as the school they attended. Additionally, the possibility of two closely located schools having the same postal code also decreased the strength of analyses using this method. As such, this dilemma presented an opportunity to conduct a brief validation study to examine and compare the variance explained in overall vulnerability by SN prevalence, after taking into account either individual aggregate SES or school neighbourhood SES. Results of this validation test informed the larger study's next steps regarding the incorporation of SES into predictive models.

In order to address this question and ensure methodological rigour, SES variables were aggregated at the individual and school level. SES variables were obtained for each school using two methods: 1) aggregated individual postal codes and 2) school postal codes. To obtain aggregated level estimates of SES for all individual kindergarten children for whom EDI was completed in a particular school, DA-level SES variable values were assigned to each child based on their postal codes, then averaged. To obtain school level SES variables, DA level SES variable values were assigned to each school based on their postal codes.

Multivariable linear regression analyses were run using school SN prevalence as the independent variable and adjusted for both aggregate and school SES measures for the outcome measure "overall kindergarten vulnerability". Results suggested that aggregated individual measures of SES explained 16% of the variance in overall kindergarten vulnerability whereas school neighbourhod SES explained 15% of the variability in the same outcome (Table 2). The four SES indicators were also

assessed for multicollinearity using a correlation matrix. As a result of these analyses, we decided to use aggregated individual measures of SES across all regression models for predicting children's vulnerability and long-term outcomes.

2.4.4 Grade 3 Education Quality and Accountability Office (EQAO) test

The EQAO tests are provincial tests that evaluate students' ability to meet provincial curriculum standards in reading, writing and mathematics (*Everything you need to know about EQAO Assessments*, 2018). The full version, including all three subjects of reading, writing and mathematics, is administered in Grade 3. In this study, Grade 3 EQAO school-level scores were obtained for corresponding schools that children attended during Cycle III EDI data collection. The tests were written between the 2012/13, 2013/14 and 2014/15 academic years when Cycle III children were in Grade 3. The school level EQAO dataset included overall performance rates of children in the three subject categories, as well as demographic information such as age, sex, percent English as Second Language (ESL), percent of students residing in Canada for three or more years prior to EQAO, percent of students entered current grade greater than or equal to 3 years prior to EQAO, and percent of students exempt from writing each section of the test.

The school level EQAO dataset was merged with the overall, school-level, Cycle III EDI/SES dataset. An extra matching step was used here similar to SES matching where the original school level EQAO dataset was first merged with an EDI school ID dataset on Ministry assigned Board School Identification number (BSID) as a one-to-one merge. This step was crucial for the incorporation of EDI school IDs into the Grade 3 school level EQAO dataset, which was the common variable for merging Grade 3 school level EQAO with Cycle III EDI/SES. This created a master dataset with individual Cycle III EDI, DA level SES, and school level Grade 3 EQAO scores. This master dataset was further aggregated at the school level one last time such that each row represented an individual school.

Table 2 Explanatory power of individual aggregate vs. school neighbourhood SES

Outcome	Model	Predictor	B	S.E.	95 % Confidence Interval for B		Adjusted R^2
					Lower Bound	Upper Bound	
Overall kindergarten Vulnerability	**Individual Aggregate SES**	SN prevalence	0.57	0.04	0.50	0.65	0.16
		% Employed	-1.11	0.20	-1.50	-0.73	
		% Post-Secondary Education	-0.31	0.04	-0.39	-0.23	
		% Non-movers	0.31	0.05	0.22	0.39	
		% Above Median Income	-6.55	0.87	-8.27	-4.84	
	School Neighbourhood SES	SN prevalence	0.54	0.04	0.46	0.63	0.15
		% Employed	-1.08	0.21	-1.48	-0.68	
		% Post-Secondary Education	-0.30	0.04	-0.38	-0.21	
		% Non-movers	-0.31	0.05	-0.40	-0.22	
		% Above Median Income	-0.07	0.01	-0.09	-0.05	

2.5 Data Analysis

All analyses were conducted using statistical software SPSS v25 ("IBM SPSS Statistics for Windows," 2018). The types of variables in the study and the assumptions associated with each of the analyses are outlined below.

The independent variable (primary predictor) in this study was school SN prevalence, which was a proportion and therefore a continuous variable. In statistical analysis, it is often desirable to have data that are normally distributed since this is a common assumption for most statistical methods. In order to ascertain this, histograms were created to explore the distributions of SN prevalence and other demographic variables.

The concurrent outcome (dependent variable) in this study was school developmental vulnerability rate, computed using individual child vulnerability, a dichotomous variable where 1=vulnerable and 0=not vulnerable. Since the research questions in this study pertain to aggregate developmental data, multivariable linear regressions were used to examine the association between school SN prevalence and school vulnerability rates in kindergarten. Similarly, associations between school kindergarten SN prevalence and Grade 3 vulnerability were explored, where Grade 3 vulnerability was determined based on scoring below level 3 and 4 on the EQAO test.

2.5.1 Multiple Comparisons

To account for multiple testing of hypothesis and to reduce the chances of obtaining spurious significant results, a Bonferroni Correction was used by dividing α value of 0.05 by the number of comparisons/predictive models, which were 10 in this study. Therefore, the new α value was $0.05/10=0.005$, thereby making results with $p < 0.005$ significant.

2.6 Ethics

Ethics approval for this study was obtained from the Hamilton Integrated Research Ethics Board. Only members of the research team had access to the data, which was stored in password protected hard drives. Data were only used and accessed for analysis at the Offord Centre for Child Studies at McMaster University in Hamilton, ON.

3.0 RESULTS

3.1 Demographic Characteristics of Study Participants

There were a total of 129,071 children potentially available for analysis who attended a total of 3587 schools. Only those who were in senior kindergarten, in class more than a month at the time of EDI completion and had less than 25% of EDI items missing were included. Of these 123,988 children, 4,834 had SN and 119,154 did not. Among children with valid EDI, data collected in 2011/12 contributed the largest proportion of children both with and without SN to the analytic sample (Table 3). Majority of the sample population spoke English. The mean age was slightly higher in children with SN (5.71 years) compared to children without SN (5.68 years). The sex distribution appears to be even in the non-SN group whereas 70% of the SN group is male. There were higher percentages of children with no EFSL, no French immersion and no Aboriginal status compared to those with EFSL, French immersion and Aboriginal status in both SN and non-SN groups. A higher proportion of children with SN were vulnerable across all domains of the EDI, including overall vulnerability, compared to their non-SN counterparts (Table 4). A detailed demographic profile of study participants is provided below.

Table 3: Descriptive statistics of Demographic Characteristics of Study Participants (individual level) stratified by SN Status
*All values are n (%) with the exception of Age, which is Mean (SD)

	No. of Participants (%)	
Characteristics	**SN (n=4834)**	**non-SN (n=119154)**
Year		
2010	1,233 (25.5)	30,708 (25.8)
2011	1,368 (28.3)	35,636 (29.9)
2012	2,233 (46.2)	52,810 (44.3)
Sex		
Males	3,391 (70.1)	60,175 (50.5)
Females	1,443 (29.9)	58,977 (49.5)
Age	5.71(0.34)	5.68 (0.30)
E/FSL		
no E/FSL	4,112 (85.1)	104,485 (87.7)
E/FSL	671 (13.9)	13,861 (11.6)
French Immersion		
No French Immersion	4,478 (92.6)	105,651 (88.7)
French Immersion	346 (7.2)	13,265 (11.1)
Aboriginal Status		
No	4,391 (89.3)	111,022 (93.2)
Yes	153 (3.2)	6,375 (5.4)
First Language		
English	3,546 (73.4)	84,310 (70.7)
Other only	439 (9.1)	13,263 (11.1)
English and Other (Bilingual)	282 (5.8)	10,334 (8.7)
English & French (Bilingual)	189 (3.9)	3,515 (2.9)
French	152 (3.1)	2,464 (2.1)
Two other languages (Bilingual)	32 (0.7)	607 (0.5)
French & Other (Bilingual)	21 (0.4)	319 (0.3)
Communicates Adequately in First Language		
Yes	2,996 (62.0)	108,273 (90.9)
No	1,586 (32.8)	3,487 (2.9)
Don't Know	229 (4.7)	6,723 (5.6)
Repeating this Grade		
No	4,632 (95.8)	117,513 (98.6)
Yes	186 (3.8)	1,104 (0.9)

Table 4: Descriptive statistics of Individual Level Vulnerability Rates for children with and without SN in the analytic sample

	% Vulnerable	
Vulnerability	**SN (n=4834)**	**non-SN (n=119154)**
Physical Health and Well Being	52.63	14.22
Social Competence	51.34	9.04
Emotional Maturity	50.48	10.08
Language and Cognitive Development	61.69	7.60
Communication & General Knowledge	58.81	11.49
On at least 1 Domain	79.87	27.54
On 2 or more Domains	64.21	13.33

3.2 School Characteristics

The primary goal of this research study was to examine the association between school level SN prevalence in Ontario and school level children's developmental health and well-being. The data were collected in a total of 3,492 publicly funded schools and the mean school SN prevalence was 4.3%. Of those, in 1,351 (38.6%) there were no children with SN. In 2141 (61.3%) schools there was at least one child with SN. Girls comprised 48.4% of all the children in schools with SN, and the overall vulnerability rate was 30.3% per school. School-level domain vulnerability rates ranged from 8.8% in Language & Cognition to 16.6% in Physical Health & Well-Being (Table 5).

Table 5: Descriptive statistics of School-Level Demographic characteristics, EDI Domain Scores and Vulnerability Rates (values in %)

		Minimum	**Maximum**	**Mean**	**SD**
Demographics	SN prevalence	0.00	85.71	4.29	6.02
	Mean Age	5.26	6.29	5.69	0.10
	Female	0.00	100.00	48.43	10.95
	EFSL	0.00	100.00	10.00	16.61
	French Immersion	0.00	100.00	8.23	24.27
	Aboriginal Status	0.00	100.00	2.16	7.80
	First Language English	0.00	100.00	77.04	28.34
Domains	PHWB	3.46	10.00	8.76	0.63
	SC	4.26	10.00	8.27	0.74
	EM	5.02	9.86	8.01	0.65
	LC	4.67	10.00	8.69	0.65
	CG	2.85	10.00	7.67	1.06
Vulnerability	PHWB	0.00	100.00	16.63	13.91
	SC	0.00	75.00	10.87	10.31
	EM	0.00	100.00	12.44	10.57
	LC	0.00	65.00	8.84	8.58
	CG	0.00	75.00	13.36	10.69
	Overall (at least 1 domain)	0.00	100.00	30.31	16.35
	2 or more domains	0.00	100.00	15.82	12.10

3.3 SES Characteristics

Across all 3,492 schools, an average of approximately 98% of the families living in the children's DAs were employed, 85% had post-secondary education, 87% were non-movers within the past year, and 43% had a household income higher than the median income of $59,139 (Table 6). Relationships between each of the four SES indicators were also evaluated using a correlation matrix (Table 7). Results showed weak correlations among the four indicators except for percent post-secondary education and percent above median income, which showed a moderate positive relationship at r= 0.573. Relationships between each of the four SES indicators and SN prevalence were evaluated using a correlation matrix, and all were weakly correlated (Table 7).

Table 6 Descriptive Statistics of School-level (in %) SES Indicators (Occupation, Education, Mobility and Income)

		Minimum	**Maximum**	**Mean**	**SD**
Occupation	**% Employed**	87.43	100.00	98.16	1.31
Education	**% Post-Secondary Education**	41.68	99.31	85.31	7.31
Mobility	**% Non-Movers**	38.87	99.26	86.52	5.78
Income	**% Above Median Income**	0.00	100.00	43.02	35.85

Table 7: Correlation matrix displaying Pearson Correlation coefficients (r) of kindergarten SN prevalence and 2006 Census SES Indicators (all r values significant at the two tailed α=0.01)

	SN prevalence	% Employed	% Post-Secondary Education	% Non-Movers
% Employed	-0.029			
% Post-Secondary Education	-0.082	0.176		
% Non-Movers	0.001	0.223	-0.027	
% Above Median Income	-0.112	0.286	0.573	0.112

3.4 EQAO Results

On average, there were approximately 38 students per school in the EQAO Grade 3 database. A higher proportion of males took the assessment compared to females, with the highest participation in writing across all three years (Table 8). Compared to writing and mathematics, there were more children exempt from the reading portion of the EQAO across all three years. The highest percent of children meeting provincial expectations was observed in writing (78.0%, 78.8%, 78.9%) across all years (Table 9). Tables 7 and 8 summarize the demographic characteristics and test outcomes of schools in the matched EQAO sample. Correlations were also evaluated between school level Grade 3 academic achievement in reading, writing and math, and school SES indicators to ensure there was no multicollinearity (Table 10).

Table 8: Descriptive statistics of School-Level Maximums, Minimums, Means and Standard Deviations of all EQAO Variables (mean values in %) by Year

Year	Variables	Minimum	Maximum	Mean	SD
2013	English speaking	0	100	91.57	27.79
	Number of Students	0	271	37.05	23.25
	Female	0	100	48.28	10.80
	Male	0	100	51.72	10.80
	Participation in Reading	0	100	96.92	5.79
	Participation in Writing	0	100	97.18	5.55
	Participation in Mathematics	0	100	97.07	5.64
	English as Second Language (ESL)	0	92	9.98	17.63
	Special Needs (Excluding gifted)	0	100	19.45	13.24
	In current school 3 or more years before EQAO	0	100	66.09	18.04
	Born in Canada	30	100	92.49	9.32
	Born outside Canada	0	70	7.41	9.31
	In Canada 3 or more years	0	45	4.94	6.11
	First Language English	0	100	16.89	22.25
	Reading-No data	0	13	0.44	1.31
	Reading-Exempt	0	42	2.44	4.10
	Writing-No data	0	13	0.45	1.32
	Writing-Exempt	0	30	2.16	3.70
	Mathematics-No data	0	13	0.49	1.36

	Mathematics-Exempt	0	36	2.23	3.84
2014	English speaking	0	100	91.62	27.71
	Number of Students	0	235	36.74	22.75
	Female	0	100	48.54	10.98
	Male	0	100	51.46	10.98
	Participation in Reading	0	100	97.05	5.69
	Participation in Writing	0	100	97.23	5.46
	Participation in Mathematics	0	100	97.21	5.42
	ESL	0	88	10.02	17.69
	Special Needs (Excluding gifted)	0	100	19.92	13.33
	In current school 3 or more years before EQAO	0	100	63.05	22.45
	Born in Canada	21	100	92.35	9.62
	Born outside Canada	0	79	7.43	9.55
	In Canada 3 or more years	0	62	4.95	6.48
	First Language English	0	100	17.11	22.32
	Reading-No data	0	18	0.45	1.42
	Reading-Exempt	0	32	2.28	3.84
	Writing-No data	0	17	0.47	1.43
	Writing-Exempt	0	32	2.11	3.61
	Mathematics-No data	0	12	0.48	1.40
	Mathematics-Exempt	0	32	2.12	3.63
2015	English speaking	0	100	91.64	27.69
	Number of Students	0	110	14.57	20.37
	Female	0	100	48.42	11.29
	Male	0	100	51.58	11.29
	Participation in Reading	67	100	97.83	3.87
	Participation in Writing	67	100	97.95	3.74
	Participation in Mathematics	67	100	97.93	3.73
	ESL	0	73	6.15	10.81
	Special Needs (Excluding gifted)	0	100	19.37	12.57
	In current school 3 or more years before EQAO	0	100	67.56	22.11
	Born in Canada	34	100	92.65	9.17
	Born outside Canada	0	66	7.20	9.14
	In Canada 3 or more years	0	50	5.09	6.66
	First Language English	0	100	18.29	22.34
	Reading-No data	0	14	0.40	1.37
	Reading-Exempt	0	27	1.69	3.11
	Writing-No data	0	13	0.41	1.35
	Writing-Exempt	0	27	1.57	3.05

	Mathematics-No data	0	13	0.41	1.34
	Mathematics-Exempt	0	27	1.59	3.07

Table 9: Descriptive statistics of EQAO results in Reading, Writing and Mathematics by Year (values in %)

Year	Variables	Minimum	Maximum	Mean	SD
2013	Reading-L3/L4	14	100	69.46	15.34
	Writing-L3/L4	0	100	78	15.44
	Mathematics-L3/L4	0	100	67.64	17.45
2014	Reading-L3/L4	7	100	70.9	15.15
	Writing-L3/L4	9	100	78.84	15.55
	Mathematics-L3/L4	0	100	67.14	17.76
2015	Reading-L3/L4	13	100	74.22	15.34
	Writing-L3/L4	7	100	78.9	15.6
	Mathematics-L3/L4	4	100	68.62	17.67

Table 10: Correlation matrix displaying Pearson Correlation coefficients (r) of Grade 3 SEN (%) and 2006 Census SES Indicators (all r values significant at the two tailed α=0.01)

	Grade 3 SEN-Reading	Grade 3 SEN-Writing	Grade 3 SEN-Math
Grade 3 SEN-Writing	.811		
Grade 3 SEN-Math	.840	.760	
% Employed	.214	.174	.220
% Post-Secondary Education	.419	.365	.420
% Non-Movers	.088	.124	.117
% Above Median Income	.332	.332	.348

3.5 Association between school SN prevalence and school kindergarten and Grade 3 outcomes

3.5.1 SN prevalence and kindergarten vulnerability

To examine the association between school SN prevalence and school concurrent and longitudinal outcome variables, multivariable linear regressions were used. Scatterplots of all independent and dependent variable pairs were roughly linear and there was no sign of multicollinearity, with Tolerance values >0.6 and Variance Inflation Factor (VIF) values all <1.8. Plots of standardized residuals for all regression models followed a diagonal line indicating normality across all values.

Approximately 5% of the variance in overall kindergarten vulnerability was explained solely by school SN prevalence (Table 11). However, 17% of the variance in overall kindergarten vulnerability was explained by the model after including children's demographics, and SES characteristics to school SN prevalence (Table 12). For every 1% increase in school SN prevalence, overall vulnerability (low on at least 1 domain), increased by 0.54%. A 1% increase in school SN prevalence also meant an increase in the school vulnerability rate in PHWB, SC, EM, LC, and CG by 0.43%, 0.39%, 0.41%, 0.31% and 0.41% respectively. School SN prevalence, demographics, and SES explained 11% of the variance in vulnerability rates in SC and EM, 12% in PHWB, 17% in LC and highest variance in explaining domain vulnerability was observed in CG at R^2= 19%. Across all models, age was also inversely correlated with vulnerability rates but was not statistically significant for any of the domains.

All four school SES measures were inversely associated with school vulnerability rates. Every 1% increase in percent employed, percent post-secondary education, percent non-movers, and percent above median income corresponded to a 0.85%, 0.31%, 0.28%, and 0.07% decrease respectively in school kindergarten vulnerability (model 1). These associations were significant across all kindergarten vulnerability domains with the exception of PHWB, where percent employed was not significant

(p=0.03), and in EM, where both percent employed and percent non-movers were not statistically significant with p= 0.49 and 0.02 respectively.

3.5.2 SN prevalence and Grade 3 EQAO achievement

Multivariable linear regressions were also performed to predict the variability in the percent of children meeting EQAO expectations in Reading, Writing, and Mathematics between 2013-2015. Models for average performance in reading, writing and math using only school SN prevalence as a predictor did not yield significant associations. Taking demographic and SES factors into account, school SN prevalence was not a significant predictor of Grade 3 EQAO school performance in any of the three subject areas. However, school kindergarten overall vulnerability was significantly associated with EQAO school performance in reading and writing (p=0.004, <0.001), but not in math (p=0.009). For every 1% increase in school overall vulnerability, the percent of children meeting provincial expectations in reading, writing and mathematics decreased by 0.07%, 0.09%, and 0.09% respectively. Students who entered current school ≥3 years prior to writing the EQAO had a significant higher likelihood of meeting provincial EQAO standards in both reading and writing by 0.07% (p= <0.001) and 0.08% (p= <0.001) respectively.

Of all the DA-level school SES indicators, percent employed was not significantly associated with the percent of children meeting provincial expectations in any of the three subject areas. However, percent post-secondary education, percent non-movers and percent above median income were all significantly associated with the percent of children meeting provincial standards in writing and mathematics, after taking school SN prevalence, demographic and school SES characteristics into account. Age, percent female, and percent ESL were not significant predictors of Grade 3 EQAO school outcomes.

Table 11: Relationships between School SN prevalence and Kindergarten and Grade 3 vulnerabilities

Predictor	Outcome	B	S.E.	*p*	95 % Confidence Interval for B		Adjusted R^2
					Lower Bound	Upper Bound	
School SN Prevalence	Overall Kindergarten Vulnerability	0.634	0.081	<0.001	0.475	0.793	0.050
	Reading at or above Provincial Level	-0.139	0.064	0.031	-0.265	-0.013	0.003
	Writing at or above Provincial Level	-0.135	0.060	0.025	-0.253	-0.017	0.003
	Mathematics at or above Provincial Level	-0.115	0.075	0.126	-0.263	0.033	0.001

Table 12: Multivariable regression models predicting School Level Developmental Vulnerabilities (1-7) and EQAO Proficiency at Provincial Standards (8-10) after taking demographic and school SES factors into account

Model	Outcome	Predictor	B	S.E.	*p*	95 % Confidence Interval for B		Adjusted R^2
						Lower Bound	Upper Bound	
1	**Overall Vulnerability (Low on at least 1 domain)**	SN prevalence	0.54	0.04	**<0.001**	0.46	0.62	0.17
		Age	-9.36	2.59	**<0.001**	-14.45	-4.28	
		% Female	-0.11	0.02	**<0.001**	-0.15	-0.06	
		% EFSL	0.07	0.02	**<0.001**	0.04	0.10	
		% Employed	-0.85	0.21	**<0.001**	-1.26	-0.44	
		% Post-Secondary Education	-0.31	0.04	**<0.001**	-0.39	-0.22	
		% Non-movers	-0.28	0.05	**<0.001**	-0.37	-0.19	
		% Above Median Income	-0.07	0.01	**<0.001**	-0.09	-0.05	
2	**Overall Vulnerability (Low on 2 or more domains)**	SN prevalence	0.50	0.03	**<0.001**	0.44	0.56	0.17
		Age	-6.47	1.92	**0.001**	-10.22	-2.71	
		% Female	-0.08	0.02	**<0.001**	-0.11	-0.05	
		% EFSL	0.04	0.01	**0.001**	0.01	0.06	
		% Employed	-0.72	0.15	**<0.001**	-1.02	-0.42	
		% Post-Secondary Education	-0.17	0.03	**<0.001**	-0.23	-0.10	
		% Non-movers	-0.18	0.03	**<0.001**	-0.25	-0.11	
		% Above Median Income	-0.05	0.01	**<0.001**	-0.07	-0.04	
3	**Vulnerable-PHWB**	SN prevalence	0.43	0.04	**<0.001**	0.36	0.50	0.12
		Age	-1.52	2.27	0.502	-5.97	2.92	
		% Female	-0.05	0.02	0.017	-0.09	-0.01	
		% EFSL	-0.06	0.01	**<0.001**	-0.09	-0.03	
		% Employed	-0.39	0.18	0.033	-0.74	-0.03	
		% Post-Secondary Education	-0.26	0.04	**<0.001**	-0.34	-0.19	
		% Non-movers	-0.20	0.04	**<0.001**	-0.28	-0.12	

		% Above Median Income	-0.05	0.01	**<0.001**	-0.07	-0.04	
4	**Vulnerable-SC**	SN prevalence	0.39	0.03	**<0.001**	0.34	0.45	0.11
		Age	-3.74	1.69	0.027	-7.06	-0.43	
		% Female	-0.06	0.02	**<0.001**	-0.09	-0.03	
		% EFSL	0.02	0.01	0.025	0.00	0.04	
		% Employed	-0.48	0.14	**<0.001**	-0.74	-0.21	
		% Post-Secondary Education	-0.08	0.03	**0.003**	-0.14	-0.03	
		% Non-movers	-0.10	0.03	**<0.001**	-0.16	-0.05	
		% Above Median Income	-0.04	0.01	**<0.001**	-0.05	-0.02	
5	**Vulnerable-EM**	SN prevalence	0.41	0.03	**<0.001**	0.35	0.46	0.11
		Age	-0.17	1.73	0.922	-3.57	3.22	
		% Female	-0.11	0.02	**<0.001**	-0.14	-0.08	
		% EFSL	0.01	0.01	0.341	-0.01	0.03	
		% Employed	-0.10	0.14	0.492	-0.37	0.18	
		% Post-Secondary Education	-0.09	0.03	**0.001**	-0.15	-0.04	
		% Non-movers	-0.07	0.03	0.020	-0.13	-0.01	
		% Above Median Income	-0.04	0.01	**<0.001**	-0.05	-0.03	
6	**Vulnerable-LC**	SN prevalence	0.31	0.02	**<0.001**	0.27	0.36	0.17
		Age	-9.32	1.36	**<0.001**	-11.99	-6.66	
		% Female	-0.03	0.01	0.021	-0.05	0.00	
		% EFSL	0.04	0.01	**<0.001**	0.03	0.06	
		% Employed	-0.78	0.11	**<0.001**	-0.99	-0.56	
		% Post-Secondary Education	-0.13	0.02	**<0.001**	-0.18	-0.09	
		% Non-movers	-0.13	0.02	**<0.001**	-0.18	-0.08	
		% Above Median Income	-0.03	0.01	**<0.001**	-0.04	-0.02	
7	**Vulnerable-CG**	SN prevalence	0.41	0.03	**<0.001**	0.36	0.46	0.19
		Age	-9.08	1.68	**<0.001**	-12.36	-5.80	

		% Female	-0.04	0.02	**0.005**	-0.07	-0.01	
		% EFSL	0.12	0.01	**<0.001**	0.10	0.14	
		% Employed	-0.75	0.13	**<0.001**	-1.01	-0.48	
		% Post-Secondary Education	-0.14	0.03	**<0.001**	-0.20	-0.09	
		% Non-movers	-0.18	0.03	**<0.001**	-0.24	-0.12	
		% Above Median Income	-0.03	0.01	**<0.001**	-0.04	-0.02	
8	**EQAO-Overall Reading Performance at/above Provincial Level**	SN prevalence	-0.05	0.07	0.461	-0.18	0.08	0.25
		Age	-9.20	3.96	0.020	-16.96	-1.43	
		% Female	0.09	0.06	0.091	-0.02	0.20	
		% ESL/ELD	-0.05	0.04	0.212	-0.12	0.03	
		% of Students in Canada ≥3 years prior to EQAO	-0.01	0.08	0.855	-0.17	0.14	
		% of Students entered current school ≥3 years prior to EQAO	0.07	0.02	**<0.001**	0.03	0.11	
		Overall kindergarten Vulnerability	-0.07	0.02	**0.004**	-0.11	-0.02	
		% Employed	0.89	0.37	0.016	0.17	1.60	
		% Post-Secondary Education	0.64	0.07	**<0.001**	0.51	0.77	
		% Non-movers	0.14	0.07	0.030	0.01	0.27	
		% Above Median Income	0.03	0.01	0.015	0.01	0.06	
9	**EQAO-Overall Writing Performance at/above Provincial Level**	SN prevalence	0.01	0.07	0.927	-0.13	0.14	0.21
		Age	-4.95	3.92	0.208	-12.64	2.75	
		% Female	0.10	0.06	0.075	-0.01	0.21	
		% ESL/ELD	-0.05	0.04	0.226	-0.12	0.03	
		% of Students in Canada ≥3 years prior to EQAO	0.19	0.08	0.011	0.05	0.34	

		% of Students entered current school ≥3 years prior to EQAO	0.08	0.02	**<0.001**	0.04	0.12	
		Overall kindergarten Vulnerability	-0.09	0.02	**<0.001**	-0.14	-0.05	
		% Employed	0.72	0.36	0.048	0.01	1.43	
		% Post-Secondary Education	0.39	0.06	**<0.001**	0.27	0.52	
		% Non-movers	0.21	0.07	**0.001**	0.08	0.34	
		% Above Median Income	0.05	0.01	**<0.001**	0.03	0.08	
10		SN prevalence	-0.06	0.08	0.442	-0.22	0.10	0.26
		Age	-11.21	4.70	0.017	-20.43	-1.99	
		% Female	0.02	0.07	0.731	-0.11	0.15	
		% ESL/ELD	-0.11	0.04	0.014	-0.20	-0.02	
	EQAO-Overall Math Performance at/above Provincial Level	% of Students in Canada ≥3 years prior to EQAO	0.11	0.09	0.224	-0.07	0.29	
		% of Students entered current school ≥3 years prior to EQAO	0.07	0.03	**0.004**	0.02	0.12	
		Overall kindergarten Vulnerability	-0.07	0.03	0.009	-0.12	-0.02	
		% Employed	0.74	0.44	0.090	-0.12	1.59	
		% Post-Secondary Education	0.71	0.08	**<0.001**	0.56	0.87	
		% Non-movers	0.25	0.08	**0.001**	0.10	0.41	
		% Above Median Income	0.06	0.02	**<0.001**	0.03	0.09	

4.0 DISCUSSION

The availability of adequate resources and support is a significant predictor of positive developmental health outcomes of children in kindergarten and beyond (Guralnick, 2005). This is even more important for children with special needs as lack of accommodation and resources can lead to poor developmental outcomes that become increasingly difficult to reverse in children's elementary schools years (Shore, 1997). Therefore, this study explores the association between aggregate level school SN prevalence and school level children's developmental health both in kindergarten and Grade 3, after considering school level neighbourhood SES factors such as employment, education, income and residential instability. Our study revealed a large variation in school SN prevalence across Ontario. Findings suggested that higher school SN prevalence was associated with increased school vulnerability in kindergarten. Indicators of low school neighbourhood SES were also shown to further contribute to the association between high school SN prevalence and developmental vulnerability. However, the contribution of school SN prevalence in kindergarten was not evident in elementary school years.

4.1 Study Findings

The objective of this study was to explore the association between school SN prevalence and the developmental health outcomes of typically-developing children both in kindergarten and Grade 3, after taking into account school level neighbourhood SES factors. Firstly, the results of this investigation suggest that there is a large variation in school SN prevalence with a range of 85%, while almost a third of all elementary schools have no reported children with SN. These results were significant even after taking into account school neighbourhood SES factors such as parental education, employment, income and rate of residential movement. While school SN prevalence in kindergarten is not significantly associated with school academic performance in Grade 3, school overall vulnerability in kindergarten was significantly associated with a 0.07-0.09% decrease in favourable academic outcomes in reading and writing in Grade 3.

4.1.1 School SN prevalence and developmental health in kindergarten

The first finding of large variation in school SN prevalence may be explained by a few factors. There are multiple differences in the financing, curriculum and delivery methods of SN programming not only across jurisdictions in Canada, but also across schools and school boards within Ontario (*Special Education in Ontario: Kindergarten to Grade 12*, 2017; Zegarac et al., 2008). In Ontario, children with SN and disabilities are identified as "exceptional pupils" by an Identification, Placement and Review Committee (IPRC) (*Special Education in Ontario: Kindergarten to Grade 12*, 2017). Unfortunately, this process often does not begin in kindergarten when children may not be exhibiting too many challenges in school (Dworet & Bennett, 2002). Therefore, these children often are not identified as having SN, which also inhibits or delays their ability to receive adequate support for their disabilities (Kohen et al., 2010). This is consistent with our study findings which show that almost a third of all elementary schools in Ontario have no children with SN, thereby hinting at inconsistencies in SN identification.

Additionally, according to a study conducted in Canada, provincial funding models for SN education across schools are moving towards a needs-based approach to funding as opposed to a categorical funding model (Kozey & Siegel, 2008). Currently, schools receive funding for SN services based on the previous year's school SN prevalence (Zegarac et al., 2008). This makes it increasingly difficult to identify special requirements, secure adequate resources and support for SN children if the current year's prevalence surpasses that of the past year (Zegarac et al., 2008). However, it is important to note that in the face of limited resources, schools and school boards still make considerable efforts to identify and support children with SN ("Driving Student Success With More Supportive Classrooms: Ontario Expanding Special Education and Putting More Educators in Schools," 2018). Whether it is placing educational assistants into classrooms to assist children with severe developmental disorders or hiring in-school mental health staff to provide timely intervention to children with SN, school staff and administration in Ontario do their best to create stimulating learning environments for all children ("Driving Student Success With More Supportive Classrooms: Ontario Expanding Special Education and Putting More Educators in Schools," 2018). Despite these efforts, it is important to further explore the impact of school SN prevalence and school developmental health outcomes to generate policy relevant evidence that can be used to address child health inequalities for children with and without SN.

Our study found significant associations between the school SN prevalence and the school developmental health of kindergarten children in Ontario. In other words, looking at typically developing children only, the vulnerability rates in schools with higher numbers of SN children were higher than vulnerability rates in schools with lower numbers of SN children. There was even higher variance explained in overall kindergarten vulnerability after including demographic and SES characteristics in the models, possibly suggesting additional contributions from these factors. Both associations were statistically significant (see 4.1.2).

Given the aggregate unit of analysis of "schools" in our study, this is a novel finding that refutes our initial hypothesis of there being no association, either positive or negative, between school SN prevalence and school kindergarten vulnerability. It is possible that teachers in schools with higher SN prevalence may be more sensitive to children showing developmental needs and therefore may be more likely to report them through their ratings of all children in their school. Thus, a positive explanation of this finding could be that increased identification enables the reporting of poor developmental health outcomes so that children receive adequate help.

Another explanation of higher vulnerability in schools with high SN prevalence could be due to poor allocation of resources for typically developing children. The need for all children to receive adequate access to resources and have proper assistance from teachers in the classroom is widely accepted (Guralnick, 2005; Maggi et al., 2004). Sometimes a high proportion of children with SN might indirectly affect the overall well-being of typically developing children by reducing the help and attention they receive from teachers (Vlachou, Karadimou, & Koutsogeorgou, 2016). A study exploring parental perceptions of how children with SN impact the development of their typically developing children suggested that parents were concerned about the amount of targeted attention provided to their typically developing children (Vlachou et al., 2016). Similarly, this might also be explained by the fact that teachers with targeted training and experience with children with SN and vulnerability may be more knowledgeable and thus, might be better at identifying problematic behaviours (Dickens-Smith, 1995; Early, Pianta, & Cox, 1999). Following this same idea, it is also possible that a lack of educational assistants in kindergarten classrooms in Ontario could further exacerbate the effect of high school-level SN prevalence on the vulnerability of typically developing children (Jordan, 2001). Studies show that teacher certification and exposure to training on inclusive education is largely associated with positive developmental health and academic outcomes for children (Dickens-Smith, 1995). Finally, high school-level SN prevalence and developmental vulnerability are independently associated with neighbourhood SES in this study, such that there is more vulnerability among typically

developing children, and higher prevalence of children with SN in poorer neighbourhoods. This will be further addressed in section 4.1.2.

4.1.2 Impact of school level SN prevalence on school level children's vulnerability rates after accounting for neighbourhood SES

The second research question in this study asks whether there are significant associations between school SN prevalence and school level kindergarten vulnerability rates, after adjusting for school level neighbourhood SES. As predicted by our hypothesis, there were significant associations between level of SN prevalence and school developmental vulnerability rate after taking school level neighbourhood SES factors into account.

Our findings also indicate that the school level SES factors explained some of the variation in school-level vulnerability. We saw that a higher percentage of parental employment in neighbourhoods across all schools in Ontario was associated with significantly lower overall kindergarten vulnerability, as well as individual domain school vulnerability rates in SC, LC and CG in kindergarten. This association was not significant in PHWB and EM domains. A plausible reason to explain the significant associations is related to parental employment and acquirement of social and financial capital that ultimately leads to higher quality care for children (González et al., 2018; Kuhlthau & Perrin, 2001). For instance, there tends to be more affordable good quality child care and assistive services for both typically developing and children with developmental challenges in neighbourhoods with families who have higher parental employment (González et al., 2018). Therefore, it seems that lower rates of school vulnerability in school areas with higher employment could be a result of more parents in the area having ample access to resources contributing to children's development. However, this might not explain why there were no significant associations in the PHWB and EM domains. There is scientific evidence that also points towards an increase in employment, particularly that of maternal employment, to be a risk factor for child health outcomes (Law, Hope, Petticrew, Roberts, & Whitehead, 2014). While this is a topic surrounded by a lot of debate, these studies have suggested that

a decrease in employment might provide parents the opportunity to attend important medical appointments and promote better lifestyle habits such as physical activities with children.

The second school neighbourhood SES factor examined in the context of school kindergarten vulnerability in this study was parental education. Our findings showed that there was also less vulnerability across all developmental domains in schools in neighbourhoods with higher rates of parental education. This is consistent with previous studies, which demonstrated that parental education could act in both direct and indirect pathways to buffer poor health outcomes in children (Case, Fertig, & Paxson, 2005; Case, Lubotsky, & Paxson, 2002). In direct ways, higher post-secondary education equips parents with the ability to better acquire and process information, which leads to improved investments in health and general parenting (Case et al., 2005). Indirect pathways of effect include higher education leading to skilled work with higher earnings, which may lead to investment and uptake of resources to cushion the effects of adverse health outcomes. Moreover, some studies showed that increasing parental education had a positive causal effect on children's learning outcomes, and this was most evident in their pre-school years and remained significant until the age of 16 (Dickson, Gregg, & Robinson, 2016; Flores et al., 1999).

The evidence in favour of the positive impact of parent education on children's outcomes is not consistent. For example, (Case & Paxson, 2002) showed that at all income levels children with higher maternal education were in very good health but there was no direct association between overall parental education and child health. However, this contrast with our results can be explained by the fact that Case and Paxson assessed parental education across all income levels to validate the contribution of household income to child health outcomes. In our study, we are examining overall school neighbourhood SES using parental education as an indicator. Therefore, our findings demonstrating more parental education is associated with better developmental health outcomes reflect the impact of neighbourhood socioeconomic disparities on child health outcomes.

Residential mobility, another factor that we examined in relation to school-level outcomes, refers to the frequency of movement of individuals within that area (Jelleyman & Spencer, 2008). Frequent moving has been associated with poverty, unemployment, and family disruption, all of which lead to poor developmental health outcomes for both typically and developing children and those with developmental challenges (Busacker & Kasehagen, 2012). In our study, a higher percentage of non-movers significantly predicted lower overall and individual domain vulnerability after controlling for other demographic factors and school SN prevalence. This is consistent with literature on residential instability and child health outcomes, where higher number of moves in child's lifetime increased behavioral problems by exacerbating pre-existing risk factors (Flouri, Mavroveli, & Midouhas, 2013; Jelleyman & Spencer, 2008). However, the results of the Busacker & Kasehagen study (2012) were slightly underpowered due to the self-reporting bias associated with outcome measurement. Our study maintains a high degree of validity by using a psychometrically sound tool for child development, and by also measuring residential mobility at the aggregate school level. High rates of moving are also associated with a lack of continuity in learning and healthcare outcomes (Mustard, Mayer, Black, & Postl, 1996). According to Mustard et al. (1996), lower levels of continuity in medical care were associated with higher rates of residential instability in a US based cohort study where maternal postal code changes were used a proxy for moving. Our study however examined the percent of movers versus non-movers in a specific DA within the past year to remain consistent across all aggregated school variables.

Finally, we examined the variation explained by overall household income on kindergarten vulnerability, similar to many other studies (Curtis, Dooley, Lipman, & Feeny, 2001; Kuehnle, 2014). Kuehnle (2014) in particular established a causal effect of family income on child health outcomes. These studies further emphasize how low family income may deprive children of the ability to receive adequate services and accommodation for their development. Given that the current study examines outcomes at an aggregate school level, we can conclude that school neighbourhood level income is

associated with higher vulnerabilities in kindergarten in the schools attended by children from these specific neighbourhoods. It is possible that schools with more students living in low-income conditions experience a higher school vulnerability rate as a result of fewer access to learning opportunities outside of school (Curtis et al., 2001). Our findings also suggest that school neighbourhood income is significantly associated with school vulnerability rates in LC, which is in line with other research exploring neighbourhood SES effects on child health (Webb et al., 2017). Income was also examined in the current study at the aggregate school level as one of several neighbourhood SES indicators to further capture the complexity of SES in analyses.

Lastly, we believe that our usage of the four most common SES indicators (parental employment status, parental education, amount of movement in the past year, and above median income) provides a strong estimate of how school neighbourhood SES affects school child health outcomes.

4.1.3 School SN prevalence in kindergarten and Grade 3 outcomes

The final research objective of this study was to examine whether associations between school-level prevalence of children with SN and kindergarten vulnerability were reflected three years later in Grade 3. Our findings did not find significant associations between school SN prevalence and school academic performance in Grade 3, either without and with inclusion of demographic and SES characteristics into account. Not surprisingly, when kindergarten vulnerability was added to the model, it was a strong predictor of school level rates of performance at or below provincial standards. In other words, school level kindergarten vulnerability rate was a stronger predictor for school level academic success in Grade 3 than school SN prevalence in kindergarten, after taking into account school demographic and SES factors.

Several studies have shown that similar patterns of developmental strengths and challenges in pre-school and kindergarten are also seen in Grade 3 (D'Angiulli, Warburton, Dahinten, & Hertzman,

2009; Lloyd & Hertzman, 2009). These previous findings support our research findings where school kindergarten vulnerability was a strong predictor of schools performing below the provincial expectations in reading and writing but not in mathematics. Additionally, previous research also supports our findings in kindergarten where moving between kindergarten and Grade 3 were risk factors for academic achievement, specifically in LC and CG domains (Davies, Janus, Duku, & Gaskin, 2016; Lloyd & Hertzman, 2009). A study examining population level associations between pre-school vulnerability and Grade 4 skills demonstrated strong associations between kindergarten vulnerability measured with the EDI and future academic success. (Lloyd, Irwin, & Hertzman, 2009). The findings of our study are in line with previous research showing that children's readiness to school in kindergarten is associated with later academic achievement, thus helping to validate the EDI in determining population level outcomes three years after collection of the EDI with increased precision (Davies et al., 2016).

More importantly, our study shows that while school SN prevalence is not a significant predictor for school Grade 3 outcomes, its effect is still indirectly present through overall school kindergarten vulnerability. This further emphasizes the need for targeted interventions for children with SN as early as possible to collectively treat vulnerabilities for children with SN and reduce the risk of vulnerabilities for children with no SN. It is widely accepted that providing positive experiences in children's early years can have a lasting impact in their lives (Shore, 1997). However, this is especially important for children with disabilities as early interventions can not only prevent the exacerbation of previous challenges but also decrease the onset of additional developmental difficulties (Guralnick, 1998). Our study provides policy relevant and population level evidence by showing that school SN prevalence is associated with the outcomes for typically developing children through their higher overall kindergarten vulnerability. In other words, having a large group of children with SN impacts typically developing children as well. We can speculate that our findings indicate that the importance of early intervention (EI) programs might go beyond their ability to mitigate needs of children with SN,

to also possibly cause a positive spillover effects for the developmental health of typically developing children in these schools. According to the World Health Organization (WHO), EI programs are classified under primary prevention of disability, secondary prevention of additional impairments, and tertiary prevention to minimize the impact of disability (Shonkoff & Meisels, 1990). The positive impact of EI programs in children is widely documented, not only from a developmental perspective but also for transition to school and long-term academic outcomes (Feldman, 2008; Guralnick, 1998; Underwood, 2012). The findings of our study, coupled with existing literature on kindergarten vulnerabilities in children stress the importance of adequate identification and provision of services to all children in their early years. The absence of proper needs identification, and therefore referral/usage of interventions will continue to exacerbate the health outcomes of both typically developing children and those with developmental challenges. Our study is also the first study in Canada to demonstrate these relationships in child health outcomes at a school level based on SN prevalence by demonstrating the variance in school SN prevalence across Ontario. Finally, the results of this study showing significant associations between school SN prevalence and the school developmental health of typically developing children should be used to promote policy level discussions in child health and education to reduce kindergarten vulnerabilities in Ontario and in Canada.

4.2 Implications of Study Findings

This study contributes to our understanding of developmental health outcomes of typically developing children by demonstrating the association between school SN prevalence and school developmental vulnerability rates after adjusting for school neighbourhood SES. We also showed that the school prevalence of children with SN in kindergarten was only moderately correlated with school neighbourhood SES, with the strongest negative correlation between school SN prevalence and school level median income. The results of this study, combined with prior research evidence and expert opinions, can be used to provide policy relevant evidence to further investigate outcomes for children by placing more emphasis on early intervention and services to improve overall school vulnerabilities for typically developing children as well. In the current study, there are several novel findings observed in the analytic models. Our findings demonstrate significant associations between school level SN prevalence and kindergarten vulnerability of typically developing children with respect to neighbourhood SES factors. These associations however do not carry through to Grade 3 academic achievement in reading, writing and math.

One novel finding from this study is that school SN prevalence has not been found to be a predictor of school Grade 3 academic outcomes. Instead, school overall kindergarten vulnerability rate is a stronger indicator of later school academic outcomes. School SN prevalence is still indirectly present since the kindergarten school SN prevalence is associated with school overall vulnerability rate, which in turn is a strong predictor of Grade 3 academic outcomes. This suggests the importance of providing children with SN adequate support in their early years to reduce their vulnerabilities, and consequently support the developmental health of typically developing children in these schools. The required emphasis on early intervention practices is consistent with previous research demonstrating its benefits in preventing developmental decline in children with SN and also creating a stimulating learning environment for typically developing children (Feldman, 2008; Underwood, 2012). Moreover,

it stresses the importance of using this knowledge of kindergarten vulnerability to improve longitudinal trajectories for children at the school level.

Our study also provides a snapshot of population level inequalities in child health outcomes by demonstrating that the association between school SN prevalence and school kindergarten vulnerability contributes to the health of typically developing children. We hope this will translate into a practical implication where schools and school boards across Ontario use this knowledge to further improve children's longitudinal outcomes. Our study also found that nearly one third of all schools in Ontario did not have any children with SN in kindergarten, and this requires further study. Future investigations can use our study as a stepping-stone to further assess how these associations affect the health of children with and without SN at an aggregate school level.

4.3 Limitations

This study has several limitations. First, the Canadian Census variables were used as they were the most in-depth socioeconomic variables at the pan-Canadian level, and would allow the most accurate approximation of school neighbourhood SES for analysis (Webb et al., 2017). Specifically, the 2006 census variables were used in order to remain as close as possible to the birth years (2004-2006) of children in the sample. However, the EDI data were collected when these children were in kindergarten, sometime between 2010-2012. Ideally, the 2011 census variables should be used for the regression models, but this was not possible due to the voluntary nature of the National Household Survey in 2011. Therefore, the first limitation is that the census variables may not accurately represent the children's neighbourhood SES in kindergarten and in Grade 3. Secondly, since the census variables were collected as a single point in time (2006), some of the associations found in this study with respect to neighbourhood SES may not be the same as what would be observed at a different point in time using a different census year. Future studies can further examine these associations using estimates of school neighbourhood SES from various census years to establish trends and patterns in children's developmental health.

Another limitation in the study relates to the use of school level EQAO data as opposed to individual level EQAO results. Specifically, EDI and neighbourhood SES data in this study were first obtained at the individual child level, then aggregated at the school level to provide the most accurate estimate of developmental health and SES of all children attending each school. However, use of this individual data was not possible as the data received were already aggregated to schools for Grade 3 EQAO test scores. This means that by matching at the school level, we may have lost some explanatory power on how SN prevalence and neighbourhood SES affect children's academic success in Grade 3 (Pollet et al., 2015). Furthermore, since our research objectives sought to understand processes at the school-level, the precision of our analyses would have been better and more realistic if we only included children who were in the same school at both times (kindergarten and Grade 3). To further

ascertain the relationship between SN prevalence and children's academic success in Grade 3, future research should link individuals in the EDI databases to those in the EQAO, and then aggregate the individual-level Grade 3 scores to the school level. Efforts should also be made to include children in the same school at both time periods to not only prevent losing valuable individual data, but also to increase the explanatory power of analyses.

Finally, it is important to note that this study explores associations between school SN prevalence and school level children's developmental health rates after taking into account school level neighbourhood SES factors, but does not attempt to make any causal inferences regarding children's developmental health.

4.4 Conclusions

This is the first study to examine associations between school level SN prevalence and children's school level kindergarten and school Grade 3 developmental health outcomes in Ontario. All analytic models showed that school SN prevalence was associated with school level kindergarten vulnerability rates across all developmental domains. However, school SN prevalence was not a significant predictor of school performance in Grade 3 reading, writing and math test scores. School kindergarten vulnerability rate – itself associated with the school prevalence of children with SN - was a stronger predictor of school Grade 3 academic outcomes than school SN prevalence after controlling for demographic and SES factors. This finding further emphasizes the importance of early intervention services to mitigate the long-term negative effects of kindergarten vulnerability on children with SN, but also shows the negative impact of high school-level SN prevalence on typically developing children. Future studies can use a validated SES index and individual child level EQAO data to further evaluate the strength of these associations.

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Appendix A: 2006 Census SES Variables

Census variables and derivation of values for School Neighbourhood SES indicators used in analysis

1. **Occupation**
   a. Total labour force 15 years and over by occupation - National Occupational Classification for Statistics 2006 - 20% sample data (includes those with and without employment)
   b. Total labour force 15 years and over by occupation - National Occupational Classification for Statistics 2006 - 20% sample data / Employed; All occupations

      % Employed= (b/a) * 100%

2. **Education**
   a. Total population 25 to 64 years by highest certificate, diploma or degree - 20% sample data (includes those with and without post-secondary education)
   b. Total population 25 to 64 years by highest certificate, diploma or degree - 20% sample data / Certificate, diploma or degree

      % Post-Secondary Education = (b/a) * 100%

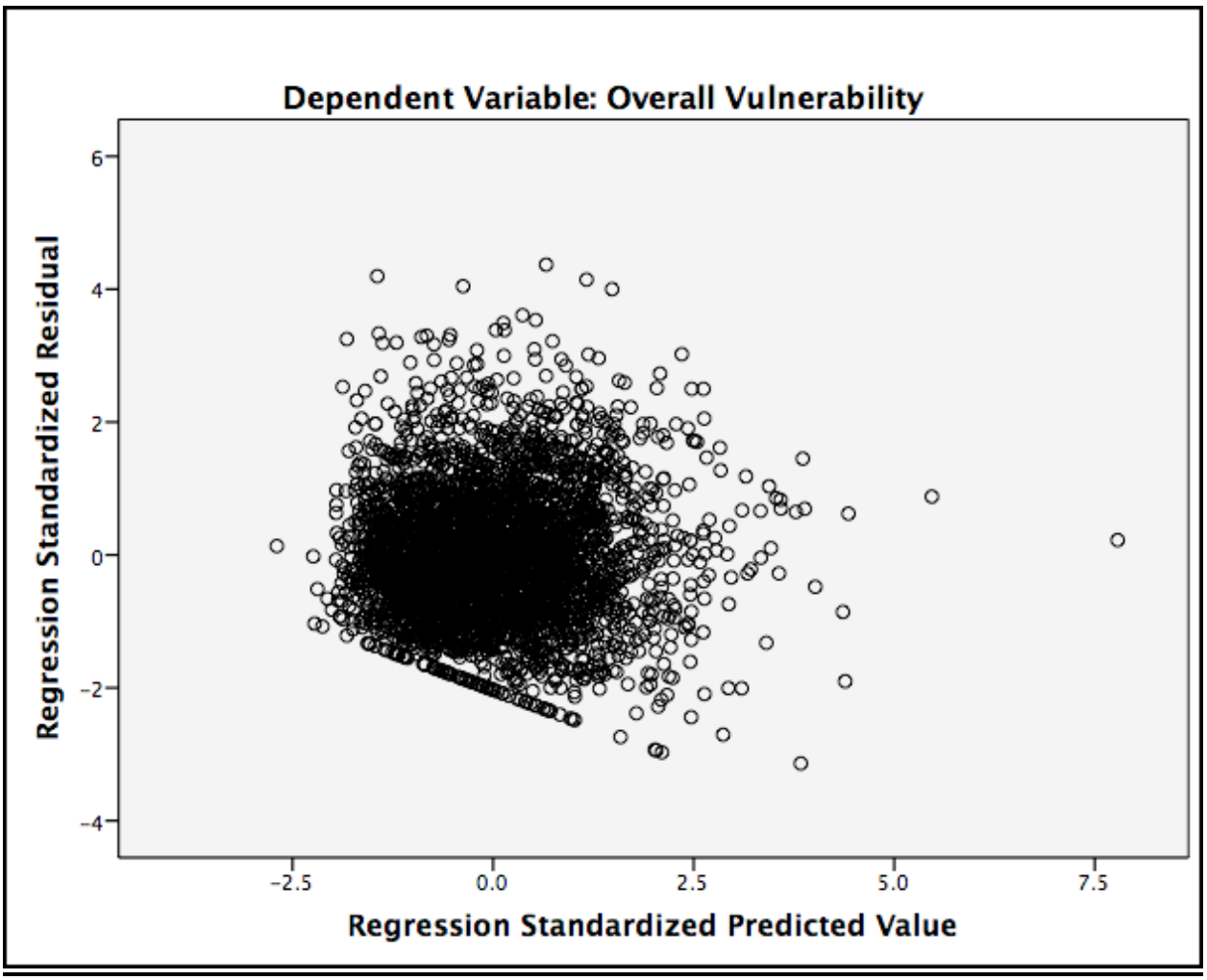
3. **Mobility**
   a. Total - Mobility status 1 year ago - 20% sample data (includes both movers and non-movers)
   b. Total - Mobility status 1 year ago - 20% sample data / Non-movers

      % Non-movers=(b/a) * 100%

4. **Income**
   a. Median Income after Tax – Percent of population above median income was derived by recoding those above the median to “1” and those below the median income to “0”, after which a proportion was obtained of all those above the median income.

Appendix B: Regression Assumptions

Multivariate Linear Regression Plot for SN prevalence vs. Overall Vulnerability, after adjusting for SES factors (Model 1 shown as example)



Regression Statistics for Model 1

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	median_income_pin, EFSL_pin, % female, age_mean_1, SN_prev_mean, movers_mean, Unemployed_mean, nopostsecEd_mean[b]	.	Enter

a. Dependent Variable: Overall Vulnerability

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.409[a]	.167	.165	14.9377

a. Predictors: (Constant), SN Prevalence, Age, % Female, % EFSL, % Unemployed, % no Post Secondary Education, % Movers, Median income.

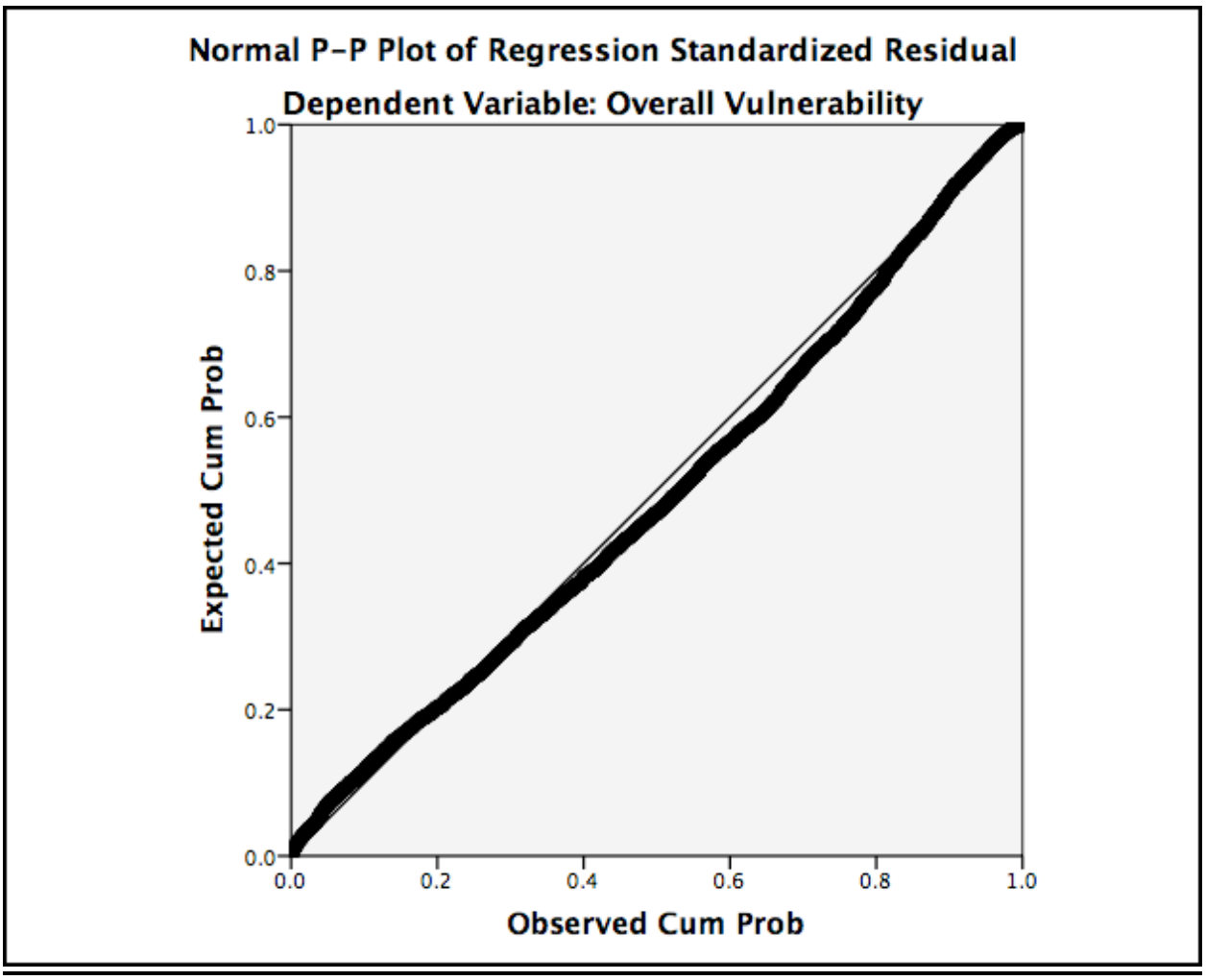
b. Dependent Variable: Overall Vulnerability

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	156095.322	8	19511.915	87.444	.000[b]
	Residual	777183.539	3483	223.136		
	Total	933278.861	3491			

a. Dependent Variable: Overall Vulnerability

b. Predictors: (Constant), SN Prevalence, Age, % Female, % EFSL, % Unemployed, % no Post Secondary Education, % Movers, Median income.


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Overall Vulnerability
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0