



Childhood poverty and school readiness: Differences by poverty type and immigration background

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ABSTRACT

Objectives: Poverty exposes children to adverse conditions that negatively impact development. However, there is limited understanding on how different types of poverty may affect children of various immigration backgrounds differently in outcomes such as school readiness. This study examined these relationships between household and/or neighbourhood poverty, poverty timing, and immigration background with school readiness outcomes at kindergarten.

Methods: This study utilized a retrospective, population-based cohort of administrative records linked with surveys completed by kindergarten teachers for 15 369 children born in British Columbia, Canada. The exposures investigated were neighbourhood poverty (residing in a neighbourhood in the lowest income-quintile) and/or household poverty (receiving a health insurance subsidy due to low household income). Experiencing both neighbourhood and household poverty simultaneously was defined as “combined” household and neighbourhood poverty. The outcome of vulnerability on school readiness domains was assessed at kindergarten (47.8% female; mean age = 6.01 years) using teacher ratings on the Early Development Instrument (EDI).

Results: Children exposed to combined poverty between age 0 and 2 had greater odds of being vulnerable in two or more domains of school readiness than children not exposed to any poverty during this period (adjusted odds ratio (aOR) = 2.07, 95% CI: [1.74; 2.47], $p < 0.001$). The effect of combined poverty was larger than household poverty only (aOR = 1.54, 95% CI: [1.31; 1.82], $p < 0.001$) or neighbourhood poverty only (aOR = 1.49, 95% CI: [1.30; 1.70], $p < 0.001$). Combined poverty was associated with negative outcomes regardless of timing. Both non-immigrants (aOR = 2.40, 95% CI: [1.92; 3.00], $p < 0.001$) and second-generation immigrants (aOR = 1.63, 95% CI: [1.22; 2.17], $p < 0.001$) experiencing combined poverty scored lower on school readiness.

Conclusions: Children who experienced combined poverty had lower levels of school readiness at kindergarten, regardless of timing and immigration background.

1. Introduction

1.1. Early poverty experience and its association to child development outcomes

Childhood poverty is associated with a myriad of harmful conditions at the household level, including exposure to family stress, nutritional deficits, and inadequate housing and living conditions, as well as in the

surrounding area or neighbourhood level such as exposure to greater levels of violence, noise, and pollutants (Evans & Cassells, 2014; Faught, Williams, Willows, Asbridge, & Veugelers, 2017; Wheeler, Jones, Schootman, & Nelson, 2019). Childhood poverty has been found to be significantly associated with increased levels of childhood mental health problems (Fitzsimons, Goodman, Kelly, & Smith, 2017), as well as lower adult attainment-related outcomes such as adult earnings and work hours (Duncan, Ziol-Guest, & Kalil, 2010). In addition, children living in

Abbreviations: BC, British Columbia; MSP, Medical Services Plan; EDI, Early Development Instrument; PHN, Personal Health Number; OR, Odds Ratio; aOR, Adjusted Odds Ratio; CI, Confidence Interval; n, number of participants.

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poverty were more likely to have lower levels of academic skills at school entry (Wolf, Magnuson, & Kimbro, 2017) as well as lower scores in other developmental outcomes across a series of domains at kindergarten (Roos, Wall-Wieler, & Lee, 2019), also known as “school readiness”, as rated by their teachers on the Early Development Instrument [EDI] (Janus & Offord, 2007). School readiness in kindergarten has been found to predict future emotional well-being, connectedness to peers, and academic achievement in middle childhood (Guhn, Gadermann, Almas, Schonert-Reichl, & Hertzman, 2016), literacy and numeracy through primary school (Brinkman et al., 2013; Romano, Babchishin, Pagani, & Kohen, 2010), as well as later adult psychosocial outcomes (Fothergill et al., 2008).

The relationship between early childhood poverty and school readiness at kindergarten has been found to also differ based upon the specific poverty timing and poverty type examined. For example, children in Manitoba, Canada who experienced both household and neighbourhood poverty at birth, or just household poverty alone, demonstrated lower school readiness than those who experienced neighbourhood poverty only (Roos et al., 2019). Children exposed to poverty both before age 2 and after age 2 generally demonstrated lower school readiness than those who did not experience poverty at multiple time-points (Roos et al., 2019). Children consistently experiencing household poverty have also demonstrated lower levels of performance in language and school-readiness than other groups, with those experiencing chronic poverty or poverty only later in childhood also having more externalizing and internalizing problems (National Institute of Child Health and Human Development Early Child Care Research Network, 2005). The present study aims to build upon this work by separately examining each type of poverty experience: household poverty only, neighbourhood poverty only, or concurrent household and neighbourhood poverty. Children who experience the co-occurrence of both household and neighbourhood poverty (referred to as “combined poverty” in this study) may experience a unique disadvantage in development in comparison to those experiencing only a single type of poverty. Previous studies in this area have explored the relationship between household poverty and/or neighbourhood poverty with school readiness in Manitoba (Roos et al., 2019), and individual poverty types with school readiness in the B.C. context (Guhn, Emerson, Mahdavian, & Gadermann, 2020). However, there is a lack of examination of how the immigration background of the child might modify that relationship, as well as whether the timing of the combined poverty exposure is associated with a unique detriment to developmental outcomes for children in B.C. The present study aims to address these gaps.

In B.C., recent immigrant children and families are disproportionately more likely to be living in poverty in comparison to non-immigrant families (Crossman, 2013). The immigration background of children, defined in the present study as whether children had parents born in Canada (non-immigrant children) or at least one foreign-born parent (second-generation immigrant children), also plays a role in child development outcomes. Unique challenges that immigrants face may exacerbate the disadvantage experienced by children living in low-income environments. An investigation of family risk profiles in Ontario, Canada, suggests that there may be immigrant children from low-income families that are falling behind in school readiness and not coming to the attention of educators and social service workers (Browne, Wade, Prime, & Jenkins, 2018). Factors contributing to these outcomes could be discrimination or social isolation related to children’s immigration background that have been found to negatively affect their health (Oxman-Martinez et al., 2012), though children living in recent immigrant families have also been found to have lower levels of emotional-behavioural problems (Georgiades, Boyle, & Duku, 2007).

Demographic differences between the immigrant and non-immigrant populations in Canada may be contributing to experiences of social isolation or discrimination that could be further exacerbated by poverty. For example, a greater proportion of the immigrant population in Canada identified as visible minorities in comparison to non-immigrants

(69.3% vs. 11.4%) (Statistics Canada, 2017c). Of the visible minority population in B.C., 63.3% is comprised of those from South Asia and China (Statistics Canada, 2017b). A greater proportion of non-immigrants in B.C. listed English as their first official language spoken (98.1%) in comparison to immigrants (88.7%), with only 49.4% of immigrants reporting that they speak mainly English at home, and 24.4% of immigrants reporting English as their mother tongue (Statistics Canada, 2019). However, despite possible social exclusion and the greater likelihood for immigrant children to be experiencing poverty, differences in within-family social capital between immigrant and non-immigrant families (De Feyter & Winsler, 2009) may relate to poverty experience being less consequential for the school readiness of immigrant children. When examining the association between poverty and developmental outcomes such as school readiness, it is important to also consider how the immigration characteristics of children’s families may alter that relationship.

1.2. Research aims

The present study had three aims: (1) Examine the relationship between early life (ages 0 to 2) household poverty, neighbourhood poverty, and combined household and neighbourhood poverty exposure on teacher-rated school readiness across 5 developmental domains at kindergarten; (2) Determine whether the timing of combined poverty exposure between ages 0 to 5 (not experiencing poverty in that time period; experiencing combined poverty only early between ages 0 to 2; experiencing combined poverty only later between ages 3 to 5; or experiencing combined poverty in both time periods) is associated with school readiness outcomes at kindergarten; (3) Determine whether the association between poverty in early life and school readiness outcomes at kindergarten differs by the immigration background of the child.

We hypothesized that: (1) Children who experienced any type of poverty during early life (between ages 0 to 2) would exhibit lower school readiness scores than those who did not experience any poverty, with those experiencing combined poverty having the lowest school readiness; (2) Children who experienced combined poverty across multiple periods of childhood, at both early life in infancy (between ages 0 to 2) and at early childhood (between ages 3 to 5), would have lower school readiness outcomes compared to those who did not experience poverty at either time point, or only experienced poverty at a single time point; (3) Combined poverty would be associated with lower school readiness for both non-immigrants and second-generation immigrants, though the detriment of poverty would be larger for second-generation immigrants.

2. Methods

2.1. Data source

This study data came from a population-based, linked dataset. This dataset is comprised of: Physician claims records (British Columbia Ministry of Health, 2017a) which came from the B.C. Ministry of Health Medical Services Plan (MSP) Payment Information File. Immigration records (Immigration Refugees and Citizenship Canada, 2017) which came from the Immigration, Refugees, and Citizenship Canada Permanent Resident Database. Provincial birth registry records (British Columbia Ministry of Health, 2017b) for birth factors and parent characteristics from B.C. Vital Events Birth Data. Neighbourhood income quintiles are aggregated at the postal code level and are adjusted for household size, which were determined from Canadian census data converted from postal codes using the Statistics Canada Postal Code Conversion File (PCCF+; Statistics Canada, 2023). Neighbourhoods are divided into five categories of equal size, from 1 (lowest income quintile) to 5 (highest income quintile). Children were categorized as living in one of the five income quintiles at each year of age based upon their family residence postal code indicated on their MSP registration. School

readiness outcomes (Human Early Learning Partnership, 2017) came from teacher-rated EDI survey data. This requested data was linked by *Population Data BC*, a center in B.C. specializing in population-level data linkage, using a probabilistic-deterministic approach (linkage rate, 98.4%; *Population Data BC*, 2021). Individual linkage across data sources was completed using multiple identifiers (i.e. Personal Health Numbers). This study was approved by a Canadian University Research Ethics Board.

The study cohort from which the analytic sample is derived includes children (48.3% Female) born between 1994 and 2006 who had resided in 10 of the highest population school districts in B.C., with study data available up to 2017. Data for the full B.C. population was not available, as such, these 10 school districts were requested for linkage from data stewards because they captured the vast majority of the immigrant population in B.C. (*Statistics Canada*, 2017c). This cohort was defined using data from the B.C. Ministry of Health and B.C. Ministry of Education, with inclusion requiring that the children were present in B.C. during the study period (Fig. 1). Yearly inclusion in provincial health insurance records (being present in the province for >274 days/year) was utilized as a proxy for children's presence in B.C. and inclusion in the present study (Guhn et al., 2020; Thomson et al., 2019).

2.2. Measures

2.2.1. Exposure of interest

The primary exposures of interest in this study are experiencing household poverty, neighbourhood poverty, or combined household and neighbourhood poverty. Combined poverty was also examined at different developmental periods, comprising of infancy (defined here as between ages 0 to 2) and/or early childhood (defined as ages 3 to 5) (Andersen, 2021), which are poverty timing categories that have been utilized in previous analyses examining the association of poverty to school readiness (Roos et al., 2019). The definition of "combined poverty" has been constructed for the purposes of this study as experiencing both neighbourhood poverty and household poverty

concurrently, utilizing definitions of neighbourhood poverty and household poverty that have been previously used in the literature (Guhn et al., 2020; Roos et al., 2019).

Neighbourhood poverty is operationalized as poverty associated with residing in a neighbourhood area that is in the lowest income-quintile relative to other neighbourhoods (Roos et al., 2019). Children's corresponding neighbourhoods were based upon the census data dissemination areas that their family residence postal code corresponded to (*Statistics Canada*, 2018). Dissemination areas typically comprise of 400–700 residents, which may be geographically compact in urban locations and larger in rural regions (*Statistics Canada*, 2018).

Household poverty is defined as receiving any health insurance subsidy (MSP subsidy) due to the low-income qualification of the child's household (Guhn et al., 2020). MSP subsidy information is available yearly for each household, with subsidies ranging from 20% to 100%, depending upon the income bracket of the household. MSP subsidy was used as a proxy for determining household poverty, as eligibility for opting-in for this subsidy is based upon the family's adjusted net income each year. During the study period, the income ceiling for those eligible to receive a subsidy increased incrementally up to \$30,000 for a family of three depending upon the year of receipt. This cut-off is comparable to the Statistics Canada after-tax, low-income cut-off for a family of three in a large metropolitan area, which was up to \$29,260 during the poverty observation period in this study (*Statistics Canada*, 2015).

For the analyses examining the effect of poverty timing on outcomes, children were categorized as experiencing combined poverty either "at both ages 0–2 and 3–5", "at 0–2 only", "at 3–5 only", or "not experiencing poverty".

2.2.2. Outcomes of interest

The EDI is a survey of children's development used population-wide to monitor early childhood outcomes (Janus, Reid-Westoby, Raiter, Forer, & Guhn, 2021). EDI data are collected in schools in systematic multi-year waves in nearly all B.C. school districts. The data collection typically occurs over a two or three-year period, and therefore does not

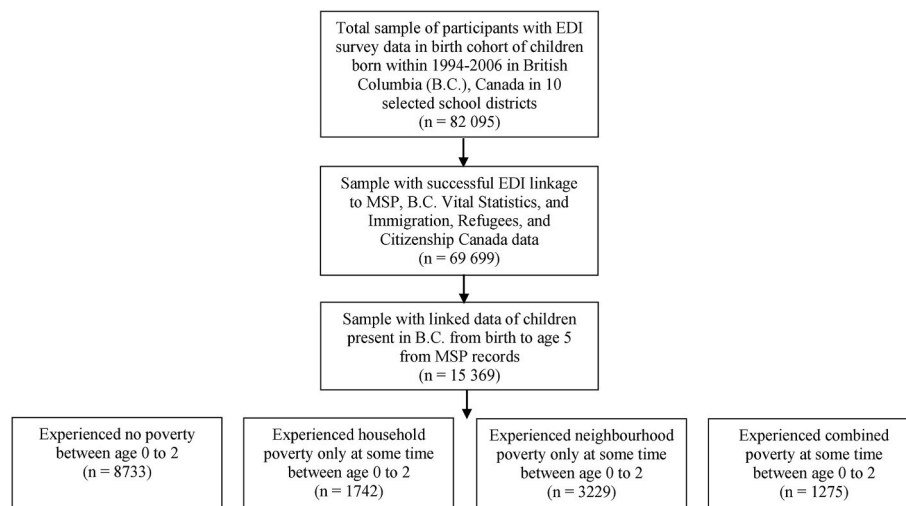


Fig. 1. Flow diagram of analytic sample inclusion and exclusion. Analytic sample inclusion was stratified by poverty exposure.

Of the 73 493 children who were present at birth in the dataset, 5695 (7.8%) were lost to follow-up by age 5 based upon registration in Medical Services Plan (MSP) health insurance records from age 0 to age 5. Children who were lost to follow-up did not differ significantly by sex, but were more likely to have been receiving MSP subsidy at age 0, to be living in the lowest income quintile neighbourhood at age 0, to be a second-generation immigrant, and on average had mothers who were younger at child birth in comparison to children who were not lost to follow-up. 15 369 participants were present in B.C. from ages 0 to age 5 and not lost to follow-up, and had successful linkages to administrative data records and a completed Early Development Instrument (EDI) survey. 397 (2.6%) of these 15 369 participants had missing EDI outcome data. Missingness in individual EDI domain scales did not appear to differ significantly between one another, and each had a missingness between 1.0% and 1.7%. 179 children (1.2%) had both household poverty and neighbourhood poverty but in different years between age 0 to 2 (not concurrent/combined household and neighbourhood poverty), and therefore were not categorized into one of the four poverty exposure groups. For children who were present in B.C. during the study period with successful data records linkages, the administrative data variables (immigrant generation status, birthweight adjusted for gestational period, mother marital status, mother age at birth category) had $\leq 1\%$ missing data.

capture all kindergarten children in B.C. every year (Human Early Learning Partnership, 2023). The questionnaire is completed by teachers in participating public school districts for each of their classroom students, six months into their kindergarten year (Human Early Learning Partnership, 2023). On average over 80% of children attending public kindergarten in these participating school districts take part in the EDI (Guhn et al., 2020). Parents/guardians are provided an informed passive consent letter with a four week notice to inquire and choose to opt their children out of participation. Individual schools and classroom teachers may also opt-out from participation.

Teachers assess children's age-appropriate skills and abilities in five domains of development: physical well-being (13 items), social competence (26 items), communication and general knowledge (8 items), emotional maturity (30 items), and language and cognitive development (26 items) (Janus & Offord, 2007). Teachers select from multiple choice response options that best described their student over the past six months. Each EDI item is rated on a 2 or 3-point (agreement scale or estimated frequency) scale with respective assigned scores of either 0/10 or 0/5/10, with an additional response option of "Don't know" which is coded as missing.

Multiple studies have provided reliability and validity evidence for the EDI (Janus, 2011; Janus & Offord, 2007), including evidence for test-retest reliability ranging from 0.82 to 0.94 (Janus & Offord, 2007), inter-rater reliability ranging from 0.53 to 0.80, and factor structuring for the five EDI domains (Forer & Zumbo, 2011; Janus & Offord, 2007). The EDI has also been adapted and validated in a number of countries beyond Canada, including Australia, USA, Brazil, Sweden and Kyrgyzstan (see Janus and Reid-Westoby (2016) for an overview), as well as for children from diverse linguistic backgrounds in B.C. (Guhn, Milbrath, & Hertzman, 2016).

A child is considered "vulnerable" on an EDI domain if their mean domain score is equal to or lower than the 10th percentile of children in the distribution of the first provincial wave of EDI data collected from the B.C. kindergarten population (method described in Janus & Duku, 2007). The 10th percentile threshold was chosen in-part to capture children who may be experiencing difficulties that are not clearly visible and not already identified in the school system (Janus & Duku, 2007). Vulnerability on the EDI has been found to predict future developmental vulnerability in middle childhood and mental health conditions into adolescence, as well as later academic outcomes in different regions in Canada (reviewed in Janus et al., 2021). To assess the relationship between poverty and risk of vulnerability across multiple developmental domains (Rossen et al., 2019), children were also categorized based upon whether they demonstrated vulnerability on "two or more domains", which is the primary outcome of interest in this study.

2.2.3. Immigration background

Differences by immigration background was also examined in the relationship between poverty and developmental outcomes. This variable was categorized as either "second-generation immigrant" (the child was born in Canada, having at least one parent who immigrated to Canada), or "non-immigrant" (any child born in Canada who did not fall under the second-generation category). To assess poverty starting from birth and to adjust for relevant confounders at birth as described below, first-generation immigrants (children who were born outside of Canada) could not be included in this study.

2.2.4. Confounders

The confounders adjusted for in the present study's analyses were based upon their previous identification and inclusion as relevant confounders in the literature. Child's sex (Janus & Duku, 2007; Leventhal & Brooks-Gunn, 2003; Webb et al., 2020), birthweight adjusted for gestational period (Farooqi, Hägglöf, Sedin, Gothefors, & Serenius, 2007; Guhn et al., 2020), parental marital status at childbirth (Guhn et al., 2020; Thomson et al., 2019), maternal age at childbirth (Falster et al., 2018; Thomson et al., 2019) and age at EDI assessment (Guhn

et al., 2020; Janus & Duku, 2007) were adjusted for as relevant confounders due to their association with poverty and risk of vulnerability on each of the EDI domain outcomes.

Separate models were fit for vulnerability on two or more domains on the EDI and individually for each of the five EDI domains.

2.3. Analyses

2.3.1. Descriptive statistics

Analytic sample demographic characteristics were calculated and compared to the general B.C. kindergarten aged population to determine whether the analytic sample differed significantly.

2.3.2. Aim 1 analysis: effect of early experience (ages 0 to 2) of poverty

Unadjusted and adjusted logistic regression models (adjusting for the previously outlined confounders) were completed to determine the association between exposure to poverty early in life (age 0 to 2) and vulnerability on two or more EDI domains. A single model was completed with children's poverty exposure categorized as experiencing "no poverty", "household poverty only", "neighbourhood poverty only", or "combined poverty".

2.3.3. Aim 2 analysis: effect of timing of combined poverty experience

To examine whether the relationship between combined poverty and EDI outcomes was dependent upon the specific timing and duration of the poverty experience, children were categorized into four different combined poverty timing groups between ages 0 to 5 as previously outlined. Unadjusted and adjusted logistic regression models (adjusting for the previously outlined confounders) were completed, and the outcomes examined were the same as in aim 1.

2.3.4. Aim 3 analysis: association of poverty and school readiness by immigration background

To examine whether the association between poverty and school readiness differs by immigration background, we included an interaction term of poverty with immigration background of the child (non-immigrant vs. second-generation immigrant) in the logistic regression analysis.

2.3.5. Sensitivity analyses

To check for robustness of primary analysis conclusions: (1) E-values (VanderWeele & Ding, 2017) were calculated for the point estimates (conditional on the measured covariates) to estimate how strongly an unmeasured confounder would have to be associated with both the combined poverty exposure and vulnerability on EDI domains to account for the observed associations. (2) Analyses examining the association between each type of poverty with individual EDI domain vulnerability were completed to understand the association between each type of poverty with specific domains of school readiness. (3) Analyses utilizing a total EDI score that was continuous and standardized to have a mean of 0 and standard deviation of 1 were completed to examine how poverty associates with the overall school readiness of a child. (4) Previous studies have identified the first 3 years of life as a period of life during which experiences may affect brain architecture in a way that later experiences do not (e.g., Tierney & Nelson, 2009). An analysis examining poverty exposure from age 0 to 3 predicting vulnerability was also completed. (5) Multi-level analyses clustering standard errors by classrooms (Garson, 2013) were also completed due to children being rated by their classroom teachers. (6) Analyses were completed to compare each poverty category to one another by rotating the reference category for poverty exposure. These analyses were done to assess whether each poverty type differed significantly from each other in their association to vulnerability.

Complete case analyses were completed. Missing data were deleted listwise in the multiple regression analyses. Data analyses were conducted in R v.3.6.1.

3. Results

3.1. Study population characteristics

In our overall sample of 15 369 children (47.8% female; mean age at kindergarten = 6.01 years), 8.3% (n = 1275, Table 1) had experienced combined poverty at some point between birth and age 2, and 7.3% (n = 1120) experienced it between ages 3 to 5. The proportion of the study sample that experienced household poverty only at some time between ages 0 to 2 was 11.3% (n = 1742), and neighbourhood poverty only was 21.0% (n = 3229). The proportion of the study sample who were non-immigrants was 75.4% (n = 11 594), and second-generation immigrants were 24.6% (n = 3775). The proportion of non-immigrants experiencing combined poverty was smaller (6.2%; n = 718) compared to second-generation immigrants experiencing combined poverty (14.8%; n = 557) ($X^2 = 273.29$, $p < 0.001$). A greater proportion of second-generation immigrants were vulnerable on two or more EDI domains in comparison to non-immigrants ($X^2 = 29.89$, $p < 0.001$). The five EDI domain scores did not appear to have a pattern of differing missing data rates (Fig. 1). The final analytic sample was 14 387 children.

Table 1
Study sample demographic characteristics. Analytic sample characteristics overall and by the proportion vulnerable on two or more Early Development Instrument (EDI) domain scales.

Characteristic	Group	Overall n (%)	Children Vulnerable on 2+ Domains n (%)
Total		15 369	1677
Poverty Exposure Between Age 0 to 2	No Poverty	8733 (56.8)	725 (43.2)
	Combined	1275 (8.3)	218 (13.0)
	Household Only	1742 (11.3)	237 (14.1)
	Neighbourhood Only	3229 (21.0)	437 (26.1)
Sex	Female	7350 (47.8)	465 (27.7)
	Male	8019 (52.2)	1212 (72.3)
Immigrant Generation Status	Non-immigrant	11 594 (75.4)	1174 (70.0)
	Second Generation	3775 (24.6)	503 (30.0)
Age		Mean = 6.01 SD = 0.10	Mean = 6.01 SD = 0.13
Birthweight Adjusted for Gestational Period	Not Low or High	12 271 (79.8)	1282 (76.4)
	High	1199 (7.8)	130 (7.8)
	Low	1899 (12.4)	265 (15.8)
Mother Marital Status	Married	12 160 (79.1)	1178 (70.2)
	Not Married	1826 (11.9)	285 (17.0)
	Other Separated/Widowed/Divorced	455 (3.0) 462 (3.0)	73 (4.4) 69 (4.1)
	Maternal Age at Birth Category	<20 20–30 >30	346 (2.3) 7745 (50.4) 7237 (47.1)

n = number of persons in the sample.
SD = standard deviation.

3.2. Effect of early experience (ages 0 to 2) of poverty

Experiencing combined poverty at any time between ages 0 to 2 was associated with significantly higher odds of vulnerability on two or more EDI domains in comparison to those who did not experience any poverty, after adjusting for demographic confounders (aOR = 2.07, 95% CI: [1.74; 2.47], $p < 0.001$) (Table 2) and in each EDI domain separately (Supplemental Table 1). Household poverty only (aOR = 1.54, 95% CI: [1.31; 1.82], $p < 0.001$) and neighbourhood poverty only (aOR = 1.49, 95% CI: [1.30; 1.70], $p < 0.001$) were also each associated with increased odds of being vulnerable on two or more EDI domains (Table 2), though household only poverty was not associated with vulnerability in emotional maturity on its own (Supplemental Table 1).

3.3. Effect of timing of combined poverty

Children who experienced combined poverty at both timepoints (between ages 0 to 2 and between ages 3 to 5) were significantly more likely to be vulnerable on two or more EDI domains (aOR = 2.50, 95% CI: [1.97; 3.17], $p < 0.001$) (Table 3) and on each EDI domain separately (Supplemental Table 2), in comparison to those who did not experience poverty at all. Regardless of timing (0–2 only, 3–5 only, or at both timepoints), any experience of combined poverty increased the odds of being vulnerable on two or more EDI domains (Table 3), and for each individual EDI domain outcome (Supplemental Table 2).

3.4. Poverty and school readiness by immigration background

The interaction between combined poverty and immigrant generation status predicting vulnerability was significant ($p < 0.05$) (Table 3). The significant interaction between combined poverty and immigrant generation status was examined further in stratified analyses that are presented in Supplemental Table 3. For non-immigrants, those who experienced combined poverty had 140% higher odds of being vulnerable on two or more domains in comparison to those who did not experience combined poverty (aOR = 2.40, 95% CI: [1.92; 3.00], $p < 0.001$) (Supplemental Table 3). For second-generation immigrants, children experiencing combined poverty had 63% higher odds of being vulnerable (aOR = 1.63, 95% CI: [1.22; 2.17], $p < 0.001$).

Table 2
Adjusted odds ratios (aOR) describing the association between poverty exposures and vulnerability on Early Development Instrument (EDI) domains.

Characteristic	Group	Vulnerable on 2+ Domains aOR [95% CI]
Poverty Exposure Between Age 0 to 2	No Poverty	Ref
	Combined	2.07 [1.74; 2.47]***
	Household Only	1.54 [1.31; 1.82]***
	Neighbourhood Only	1.49 [1.30; 1.70]***
Sex	Female	Ref
	Male	2.80 [2.49; 3.16]***
Immigrant Generation Status	Non-immigrant	Ref
	Second Generation	1.29 [1.14; 1.46]***
Age		0.70 [0.41; 1.18]
Birthweight Adjusted for Gestational Period	Not Low or High	Ref
	High	0.95 [0.78; 1.17]
	Low	1.54 [1.32; 1.79]***
Mother Marital Status	Married	Ref
	Not Married	1.63 [1.39; 1.90]***
	Other	1.67 [1.28; 2.19]***
	Separated/Widowed/Divorced	1.58 [1.19; 2.09]***
Maternal Age At Birth Category	20-30	Ref
	<20	1.04 [0.75; 1.44]
	>30	0.86 [0.77; 0.96]**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3

Adjusted odds ratios (aOR) describing the associations between poverty exposure timing and the interaction between poverty and immigrant generation status with vulnerability on Early Development Instrument (EDI) domains.

Characteristic	Group	Vulnerable on 2+ Domains aOR [95% CI]
Analysis 1: Combined Poverty Timing		
Combined Poverty Timing Category	No Poverty	Ref
	0-2 and 3-5	2.50 [1.97; 3.17]***
	0-2 Only	2.35 [1.84; 3.01]***
	3-5 Only	2.58 [1.97; 3.38]***
Analysis 2: Poverty and Immigrant Generation Status Interaction Analysis		
<i>Main Effects</i>		
Poverty Exposure Between Age 0 to 2	No Poverty	Ref
	Combined	2.40 [1.92; 3.00]***
	Household Only	1.50 [1.22; 1.84]***
	Neighbourhood Only	1.58 [1.35; 1.85]***
Immigrant Generation Status	Non-immigrant	Ref
	Second Generation (2nd-gen.)	1.45 [1.20; 1.75]***
<i>Interaction Effects</i> (Ref = No Poverty, Non-immigrant)		
Combined Poverty(yes) *2nd-gen.		0.68 [0.47; 0.97]*
Household Poverty(yes) *2nd-gen.		1.03 [0.73; 1.46]
Neighbourhood Poverty (yes)*2nd-gen.		0.80 [0.59; 1.08]

*p < 0.05, **p < 0.01, ***p < 0.001.

According to likelihood ratio tests, model fit was not improved by including the interaction term between immigration background and poverty for vulnerability on two or more EDI domains (p > 0.05).

3.5. Sensitivity analyses

(1) Based on the calculated E-value, conditional on the measured covariates, an unmeasured confounder associated with combined poverty between ages 0 to 2 and vulnerability on two or more EDI domains would require an odds ratio greater than 3.56 (with an upper confidence limit of 2.87) to explain the estimated exposure effect (VanderWeele & Ding, 2017). (2) Analysis results for the association between poverty with individual EDI domain vulnerability are presented in Supplemental Tables 1 and 2 (3) Combined poverty between ages 0 to 2 was associated with lower standardized total EDI score (B = -0.41, 95% CI: [-0.47; -0.35], p < 0.001); household poverty only (B = -0.26, 95% CI: [-0.31; -0.21], p < 0.001); neighbourhood poverty only (B = -0.20, 95% CI: [-0.24; -0.16], p < 0.001) (Supplemental Table 4). Primary analysis results utilizing standardized total EDI score are presented in Supplemental Tables 4 and 5 (4) Poverty exposure from age 0 to 3 yielded similar conclusions to the primary analysis (Supplemental Table 6). (5) Multi-level analysis which clustered standard errors by classroom indicated similar results to the primary analysis (Supplemental Table 7). (6) Combined poverty was associated with higher odds of vulnerability in two or more domains in comparison to exposure to either household poverty only or neighbourhood poverty only (Supplemental Table 8). Household only and neighbourhood only poverty did not differ significantly from one another in predicting vulnerability in two or more domains. Sensitivity analysis results are presented in further detail in Supplemental Table 1 through 8.

4. Discussion

Children who experienced combined poverty at any time prior to school entry were observed to have lower levels of school readiness at

kindergarten than those who did not experience combined poverty. The effect of combined poverty on vulnerability on two or more school readiness domains was also larger than the association between household poverty only or neighbourhood poverty only with school readiness.

Consistent with previous work in this area examining household and/or neighbourhood poverty (Faught et al., 2017; Roos et al., 2019), combined poverty in infancy was associated with higher vulnerability on the EDI. As hypothesized, experiencing only one poverty type was associated with less developmental vulnerability at kindergarten in comparison to experiencing both poverty types simultaneously. Our findings also add additional context to previous investigations examining timing of poverty exposure (Leventhal & Brooks-Gunn, 2003; Roos et al., 2019), in that combined poverty at any time between ages 0 to 5 was associated with a detriment to developmental outcomes at kindergarten.

In the present study, a greater proportion of immigrants had experienced combined poverty and were more likely to be vulnerable on two or more EDI domains in comparison to non-immigrants. Combined poverty was associated with lower levels of school readiness for both non-immigrant and second-generation immigrant children at kindergarten, though the effect of poverty was larger for non-immigrants than for second-generation immigrants. This finding suggests that poverty reduction strategies would benefit developmental outcomes of both non-immigrant and second-generation immigrant children. However, the generally lower income of immigrants in comparison to non-immigrants (Crossman, 2013) may be contributing to their lower levels of school readiness overall for the second-generation immigrants, and the smaller disparity observed in developmental outcomes between those experiencing poverty and not experiencing poverty. Immigrant families may also be facing unique challenges such as a loss in ability to maintain and engage with their cultural heritage over time (Harker, 2001) that may be a detriment to children's school readiness regardless of poverty exposure. Finally, difficulties in accessing resources for immigrant families due to factors such as cultural or language barriers may exacerbate challenges in navigating government systems and services such as healthcare (Salami et al., 2020) and education, contributing to detriments to developmental outcomes for this group overall.

4.1. Strengths and limitations

This project utilized a linked dataset containing both administrative records as well as teacher-reported survey data. This linkage and large sample size allowed for a unique examination of children's experiences of each poverty type, including the less prevalent exposure of combined household and neighbourhood poverty, while considering immigration characteristics and controlling for potentially confounding demographic characteristics. This study uniquely examined exposure to each of combined household and neighbourhood poverty, household poverty only, or neighbourhood poverty only, to allow for a better understanding of the association of each type of poverty experience to future school readiness. Another strength is that in the teacher-reported EDI surveys, the response rate within each participating school district was high, with on average over 80% of children attending public kindergarten in these school districts participating in the EDI (Guhn et al., 2020).

This study has some limitations. First, specific household income data were not available, so health insurance subsidy was used as a proxy for household poverty. This may have underestimated household poverty, as families need to opt-in, and economic analyses suggest that approximately one quarter of households eligible for a MSP subsidy fail to receive the subsidy in B.C. (Warburton, 2005). Those experiencing the most severe levels of poverty may be less likely to complete the process of opting into the health insurance subsidy, or of interacting with government services and therefore limiting their inclusion in the present study. This limitation may potentially be contributing to a bias towards the null in the relationship between poverty and developmental outcomes.

Although children resided within neighbourhoods, we did not cluster observations by neighbourhood in a multi-level model. Children may have moved between neighbourhoods between birth and kindergarten assessment, and therefore could have belonged to multiple clusters over this period, for varying durations of time (see also Roos et al., 2019). However, a multi-level model clustering children by the classroom in which they were assessed at kindergarten was completed and had a similar result to the primary analysis.

The data was also restricted to the ten highest population school districts in British Columbia, which limits the generalizability of these findings nationally or to more rural regions of B.C. There are demographic differences between the population of B.C. and the national averages. For example, in 2015, there was a higher rate of households with low-income (15.5%) in B.C. in comparison to Canada as a whole (14.2%) (Statistics Canada, 2017a). A greater proportion of the B.C. population was born outside of Canada than the national average (28.3% versus 21.9%) (NewtoBC, 2018) and a greater proportion identifies as of Asian descent than the national average (28.8% versus 17.7%). Although this study's findings are not generalizable to Canada as a whole, policies impacting children's care services and education in Canada differ significantly between provinces (Lafontaine-Émond, 2021). While there are benefits in using a nationally representative sample, focusing the analyses within one province provides more locally contextualized, actionable evidence. The present study utilized a sample from public schools, which is what most elementary school students in B.C. attend (approximately 85–90%) (Government of B.C., 2022). This may also limit generalizability to families with children who attend independent schools, who tend to be higher in income than those attending public school (Frenette, Ching, & Chan, 2015).

4.2. Future directions

In B.C., eligible families, including immigrant families, can receive tax-free, monthly payments called the B.C. Family Benefit in addition to the national Canada Child Benefit (CCB) (Government of B.C., 2023) to help with the cost of raising children under the age of 18. The benefits of these programs have been expanded since the end of the current study period, and could be investigated for their potential association to changes in school readiness of children in B.C. Although financial assistance programs such as direct cash transfers are available to both non-immigrant and immigrant families, it is critical to also reduce obstacles such as requirements to opt-in, and impediments that immigrant families might uniquely be facing in accessing government services and resources, such as language or cultural barriers.

4.3. Conclusion

This study reinforces the importance of economic policies to support low-income families, which have been associated with a reduction in negative health outcomes for children (Forget, 2011; Milligan & Stabile, 2011). Interventions to alleviate poverty may yield the greatest benefit when administered both early and consistently, as indicated by the observed developmental vulnerability associated with combined poverty experienced at any time point prior to kindergarten. Children exposed to combined household and neighbourhood poverty experienced a greater detriment to their school readiness in comparison to those who experienced household poverty only or neighbourhood poverty only, and therefore may benefit the most from intervention. Finally, immigrant groups may benefit from modifications made to improve accessibility to resources and benefits to reduce disparities in development and levels of poverty.

Data disclaimer

Access to data provided by the Data Steward(s) is subject to approval, but can be requested for research projects through the Data

Steward(s) or their designated service providers. All inferences, opinions, and conclusions drawn in this publication are those of the author(s), and do not reflect the opinions or policies of the Data Steward(s).

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Conflict of interest disclosures (Includes financial disclosures)

The authors have no conflicts of interest to disclose.

Ethical Statement

- 1) This material is the authors' own original work, which has not been previously published elsewhere.
- 2) The paper is not currently being considered for publication elsewhere.
- 3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
- 4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
- 5) The results are appropriately placed in the context of prior and existing research.
- 6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
- 7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

The violation of the Ethical Statement rules may result in severe consequences.

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I agree with the above statements and declare that this submission follows the policies in the Guide for Authors and in the Ethical Statement.

Data availability

Datasets are not readily available due to its storage on a Secure Research Environment with Population Data BC (see <https://www.popdata.bc.ca>). Contact anne.gadermann@ubc.ca for data access requests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2023.101563>.

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