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Concentrated affluence, concentrated disadvantage, and children's readiness for school: A population-based, multi-level investigation

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ABSTRACT

A number of studies demonstrates a relationship between neighbourhood concentration of affluence and disadvantage and the health and development of its residents. We contribute to this literature by testing hypotheses about the relationship between neighbourhood-level concentrated affluence/disadvantage and child-level developmental outcomes in a study population of 37,798 Kindergarten children residing in 433 neighbourhoods throughout the province of British Columbia, Canada. We utilise a previously-validated measure of neighbourhood socioeconomic composition—the *Index of Concentration at the Extremes (ICE)*—which not only allows for more precise estimation of the competing influences of concentrated affluence and disadvantage, but also facilitates examination of the potential impact of neighbourhood-level income inequality. Our findings show that increases in neighbourhood affluence are associated with increases in children's scores on the *Early Development Instrument (EDI)*, a holistic measure of Kindergarteners' readiness for school. Particularly noteworthy is that, for four of the five EDI scales (physical, social, emotional, and communication) and the total score, results indicate a significant *curvilinear* relationship – whereby the highest average child-level outcomes are not found in locations with the highest concentrations of affluence, but rather in locations with relatively equal proportions of affluent and disadvantaged families. This finding suggests, first, that concentrated affluence may have diminishing rates of return on contributing to enhanced child development, and, second, that children residing in mixed-income neighbourhoods may benefit both from the presence of affluent residents and from the presence of services and institutions aimed at assisting lower-income residents. Implications and future directions are discussed.

Introduction

Extensive literature demonstrates that neighbourhood-level socioeconomic conditions impact residents' well-being via a variety of mechanisms (Diez-Roux, 2001; Macintyre, Ellaway, & Cummins, 2002; Robert, 1999; Sampson, Morenoff, & Gannon-Rowley, 2002). A significant portion of this "neighbourhood health effects" literature has focussed on investigating the links between a given neighbourhood's *concentrated disadvantage or poverty* – i.e., its proportion of socioeconomically-disadvantaged persons, households, or families – and the health and developmental outcomes of its residents (e.g., Carpiano, 2007; Eibner & Sturm, 2006; Haan, Kaplan, & Camacho, 1987; Ross & Mirowsky, 2001). Far fewer studies, however, have examined the influences of neighbourhood-level concentrations of both affluence *and* disadvantage on these outcomes. The theoretical rationale for considering both affluence and disadvantage simultaneously is that the increased proportion of affluent residents provides greater availability of material and psychosocial resources that have distinct implications for health and well-being and that cannot be deduced by examining concentrated disadvantage alone (Massey, 1996; Wilson, 1987; see also Browning, Cagney, & Wen, 2003). To date, considerable evidence exists that neighbourhood affluence has a positive effect on health and development (e.g., Brooks-Gunn, Duncan, Klebanov, & Sealand, 1993; Weden, Carpiano, & Robert, 2008; Wen, Browning, & Cagney, 2003) which, as noted by Browning et al. (2003), calls into question the dominant focus in the neighbourhood effects literature on the prevalence of poverty and disadvantage.

In evaluating the influence of affluence, existing studies have included measures of both concentrated affluence and disadvantage in the same statistical models to determine which factor was more important empirically in predicting outcomes. A limitation of this analytic approach, however, is that proportions of affluent and

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poor families are highly correlated across neighbourhoods: As the proportion of affluent families reaches 1.0, the proportion of poor families necessarily approaches 0.0. This relationship is not completely singular due to the presence of middle class families; the relationship is, however, still strong enough to introduce problems related to multicollinearity into statistical estimates, thereby limiting inference (see Casciano & Massey, 2008).

In light of these issues, we utilise a previously-validated composite measure of neighbourhood socioeconomic composition to test two competing hypotheses about the relationship between concentrated affluence and disadvantage and child developmental outcomes. Specifically, we utilise the *Index of Concentration at the Extremes (ICE)* (Massey, 2001) to measure neighbourhood concentrated affluence and disadvantage and, in turn, explain variation in child-level scores on the *Early Development Instrument (EDI)*, a holistic measure of Kindergarten children's readiness for school (Janus & Offord, 2007; Janus et al., 2007). Our study population consisted of 37,798 children residing in 433 neighbourhoods throughout the province of British Columbia, Canada.

As Lloyd and Hertzman (2009) describe, social epidemiological approaches to the life course and health (Kuh & Ben-Shlomo, 1997) have begun to be complemented by a human development approach, which emphasises the role of early experiences as determinants of health over the life course (Schoon, Sacker, & Bartley, 2003). Early physical, socioemotional, and language/cognitive development have been shown to be associated with mid-life health and well-being through a mixture of latent, pathway, and cumulative effects (Hertzman & Power, 2005; Hertzman, Power, Matthews, & Manor, 2001). These developmental domains, which we investigate herein, have been shown to be predictors of health and well-being over the life course and, consequently, demonstrate that early child development is a determinant of health (World Health Organization, 2007). Therefore, by more fully understanding the nature of the relationship between neighbourhood-level socioeconomic characteristics and child-level outcomes, population health researchers can investigate in a more focussed manner the mechanisms that connect variations in neighbourhoods' characteristics with the overall health and development of its young children.

Theoretical Background and Hypotheses

A variety of theoretical explanations have been offered for why neighbourhood socioeconomic composition matters for health and well-being (e.g., see Mayer & Jencks, 1989; Robert, 1999). Our study tests two competing hypotheses concerning the shape of relationship between concentrated affluence/disadvantage and child development. Below, we review these hypotheses in the context of the theories that motivate them, and discuss their conceptual and empirical implications for child development.

Hypothesis 1: Benefits of Affluent Neighbours for Development (BAND)

The first hypothesis, which we refer to here as the *Benefits of Affluent Neighbours for Development (BAND)* hypothesis, is based on the collective findings of prior literature that has examined neighbourhood concentrated affluence and individual health and well-being: that there is a positive relationship between a neighbourhood's concentration of affluence and its individual child-level development outcomes, such that the higher the concentration of affluence in a neighbourhood, the better a child's development (even after controlling for individual and family factors of the child). The rationale for this argument is that higher concentrations of neighbourhood affluence positively influence child development through the beneficial effects of higher-quality public services (e.g., schools, parks, and police protection) and private services (e.g., sports and other activities), as well as neighbourhood monitoring of child behaviour and the increased presence of positive role models (Brooks-Gunn et al., 1993). Likewise, from the standpoint of collective socialisation, it has been argued that living among affluent neighbours encourages child competence, achievement in school, and avoidance of problem behaviours (Kohen, Hertzman, & Brooks-Gunn, 1998).

As argued by sociologist William Julius Wilson (1987) in his influential study of urban poverty, *The Truly Disadvantaged*, the poor derive benefits from the presence of more affluent residents in a neighbourhood. The prevalence of affluent residents is associated with material and social resources necessary for maintaining institutions such as the family, churches, schools, stores, and informal services. In addition to concentrated affluence, such institutions have been argued to help foster social cohesion and informal social control, which are key elements of collective efficacy for children—that is, a neighbourhood's "shared expectations and mutual engagement by adults in the active support and social control of children" (Sampson, Morenoff, & Earls, 1999, p. 635). In their study of neighbourhood-level influences on child outcomes, Brooks-Gunn et al. (1993) found that the presence of high income residents was more important in alleviating deleterious outcomes than the presence of low income residents was for generating them.

Thus, from a multi-level perspective, this BAND hypothesis argues that greater neighbourhood concentrated affluence is beneficial for a child's development. In light of this hypothesis, we would expect empirically to see a positive relationship between neighbourhood concentrated affluence and developmental outcomes of individual children.

Hypothesis 2: Competition

We also consider an alternative hypothesis—which we refer to here as the Competition hypothesis—which posits that increases in the neighbourhood prevalence of affluent residents may, in some instances, be disadvantageous for child development. This hypothesis is motivated by two theoretical streams: competition and relative deprivation theories.

Competition theories are based on the premise of limited resources, thereby suggesting that when there is competition for scarce resources, affluent neighbours can be seen as increasing competition among families (Kohen et al., 1998; Mayer & Jencks, 1989). Consistent with such theories, increasing concentrated affluence may also negatively impact trust and social engagement among neighbours, generating low levels of social capital and producing less nurturing social environments (Kawachi & Kennedy, 1997; Wilkinson, 1996), which, in turn, may contribute to worsened child-level outcomes in general.

Relative deprivation theory suggests that status differences among individuals may generate stress-inducing comparisons to others that, in turn, have potentially negative consequences for behaviours, attitudes, health and well-being (Wilkinson, 1996; see also Hou & Myles, 2005). Consistent with this theory, parents in neighbourhoods where either all families are affluent or all families are poor should experience less stress and consequently less deleterious consequences (for both parent and young child) from evaluating their situation or relative standing vis-à-vis their neighbours (Brooks-Gunn et al., 1993).

Although it has been typically argued that families are better off in more affluent neighbourhoods due to the availability of local resources, recent research conducted in the United States reveals that the number of childcare centres does not decrease as

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neighbourhood concentrated poverty increases and that increased concentrated poverty is associated with increases in a variety of local area businesses (Small & McDermott, 2006). Thus, from the standpoint of this competition hypothesis, theoretical and empirical reasons exist for arguing that neighbourhoods with higher concentrations of either affluence or disadvantage could be more beneficial for at least some aspects of child development than more mixed-income neighbourhoods. Furthermore, despite claims that income distribution is too homogeneous at the neighbourhood level to study the health impact of income inequality (Wilkinson, 1997), sufficient evidence exists to support the argument that neighbourhoods (in Canada as well as the United States) contain substantial income heterogeneity (see Hou & Myles, 2005). Thus, in line with the arguments of other authors (see Wen et al., 2003), we contend that neighbourhoods provide an excellent level of analysis for examining the potential influence of competition and relative deprivation.

In light of this competition hypothesis, one would expect to see that child development outcomes *improve* as neighbourhood socioeconomic composition becomes increasingly more *homogeneous*. Fig. 1 graphically illustrates the BAND and competition hypotheses with respect to neighbourhood concentrated affluence and disadvantage and child-level health and development.

Method

The population-based child-level data included in this paper are collected by the Human Early Learning Partnership (HELP) and are stored in a secure facility at the University of British Columbia. Central to this system are collections of Early Development Instrument (EDI) school readiness data for Kindergarten children throughout the province of British Columbia, Canada. Written approval from the University of British Columbia's Behavioural Research Ethics Board was received in order to conduct this research. The identity of individual children was not known to the researchers, and strict data confidentiality and security guidelines were followed closely. The neighbourhood-level socioeconomic data described later were used with permission from Statistics Canada.

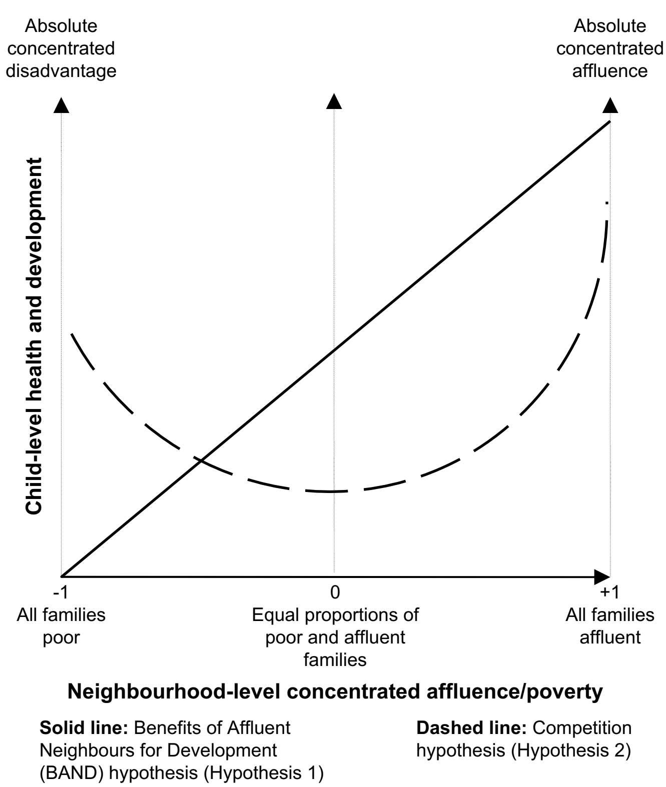

Fig. 1. Hypothesised relationship between neighbourhood-level concentrated affluence/poverty and child-level health and development.

Study Population

Our study population contained records for 37,798 children who were, in turn, nested within 433 distinct neighbourhoods. The count of children within neighbourhoods ranged from 40 to 421 ($M = 87.29$, $SD = 47.49$). To ensure that the child-level data and neighbourhood-level data were comparable temporally, the 37,798 child records represent EDI data that were collected in the 2001/2002, 2002/2003, or 2003/2004 school years, inclusive. The three school years were collapsed for the purpose of our analyses, although it should be noted that the majority of the child records were collected in 2002/2003 (the first school year in which the EDI was administered systemically throughout BC).

In accordance with the recommendations of one of the EDI's lead creators (Janus et al., 2007), forty was selected as the minimally-acceptable count of children per neighbourhood to ensure statistical stability and anonymity in the results. In addition, having too few children per neighbourhood may lead to underestimation of ecological explanatory variables (Sellström & Bremberg, 2006). A similar children-per-neighbourhood EDI cut-off has been used by Kershaw, Irwin, Trafford, and Hertzman (2005) and Lloyd and Hertzman (2009). After applying this recommended data condition (Janus et al., 2007), we retained nearly all of the total child records (37,798/39,312 = 96%) and the vast majority of the neighbourhood records (433/478 = 91%). A limitation of this data condition is that the excluded neighbourhoods were all rural (described more fully in the next section). Table 1 depicts the distribution of the record counts according to gender, Aboriginal (Indigenous) status, and English as a Second Language (ESL) status.

Defining Neighbourhood Boundaries

HELP provided Statistics Canada with its linked database's child-level postal code data and its definition of neighbourhood boundaries. In turn, Statistics Canada aggregated their census data—which we model in the current study—to the neighbourhood level using HELP's neighbourhood boundaries. Kershaw et al. (2005) describe how HELP defines its neighbourhood boundaries:

> *[We] worked closely with communities to benefit from local knowledge in determining neighbourhood boundaries that more accurately reflect the experience of a diverse range of people who reside in the area. Local [early childhood development] coalition representatives were invited to draw lines on maps of their area to signal the presence of perceived divides in their community. While some local coalitions opted to maintain the Census or another existing boundary system, others opted for dramatically different breakdowns than those employed for survey data collection* (p. 6).

Table 1
Counts: child-level variables.

	Gender		Aboriginal status		ESL status	
	Female	Male	Non-Abor	Abor	Non-ESL	ESL
N	18,399	19,399	35,010	2788	31,593	6205
% of 37,798	48.7	51.3	92.6	7.4	83.6	16.4

Our census holdings indicate that the total count of occupied private dwellings among the 433 neighbourhoods studied in this paper ranges from a minimum of 415 to a maximum of 28,245 ($M = 3617$, $SD = 2911$). Approximately 82% of BC's neighbourhoods are classified as urban, compared to 18% that are classified as rural (Lloyd & Hertzman, 2008).

Child-Level Outcome: Early Development Instrument (EDI)

In British Columbia the transition year from preschool to school is called Kindergarten, which begins in September of the year the child turns five years old. After approximately six months of knowing the children, teachers complete the EDI on behalf of their children. The EDI has been or is currently being administered in several provinces across Canada – namely British Columbia, Manitoba, Québec, and Ontario. In addition, the EDI is being piloted and/or administered in several jurisdictions outside of Canada, including Australia, Chile, Jamaica, Kosovo, and the United States. The EDI data collection includes all children in public schools, independent schools, and schools on Aboriginal reservations. Each EDI cohort represents more than 95% of the children who reside in a given catchment area, including children who speak English as a Second Language, who are Aboriginal, and who have special education needs.

The EDI contains five scales (Janus et al., 2007): *Physical health and well-being* (gross and fine motor skills, pencil holding, running on the playground, motor coordination, energy levels for classroom activities, independence in looking after own needs, and daily living skills); *Social knowledge and competence* (curiosity about the world, eagerness to try new experiences, knowledge of standards of acceptable behaviour in a public place, ability to control own behaviour, appropriate respect for adult authority, cooperation with others, following rules, and ability to play and work with other children); *Emotional health and maturity* (abilities to reflect before acting, balance between too fearful and too impulsive, abilities to deal with feelings at age-appropriate levels, and empathic responses to other people's feelings); *Language and cognitive development* (reading awareness, age-appropriate reading and writing skills, age-appropriate numeracy skills, board game performance, abilities to understand similarities and differences, and ability to recite back specific pieces of information from memory); and *Communication skills and general knowledge* (skills to communicate needs and wants in socially appropriate ways, symbolic uses of language, story telling, and age-appropriate knowledge about the life and world around them). Each scale's scores range from 0 to 10, and the total score ranges from 0 to 50. The EDI's lead creators, Janus and Offord (2007), describe the EDI's robust psychometric properties and provide justification for our having modelled scale scores.

Child-Level Sociodemographic Controls

We utilised in our analyses all of the child-level covariates to which we had access: gender (1 = male), Aboriginal (Indigenous) status (1 = Aboriginal), English as a Second Language status (1 = ESL), and the year of the EDI data collection (to control for possible cohort/age effects). Similar child-level controls were utilised by Lapointe, Ford, and Zumbo (2007) and Lloyd and Hertzman (2008) in their study of the effects of neighbourhood environments on children's readiness for school. We purposefully refrained from including special needs status as a child-level covariate in our analyses because recent province-wide research demonstrates that BC's children with special needs represent a very diverse and heterogeneous subpopulation. Therefore, dichotomising children as 'special needs' or 'non-special needs' in fact serves to homogenise a very heterogeneous population (Lloyd, Irwin, & Hertzman, 2007). Moreover, because the special needs status flag contained in the child-level database also captures children who are gifted, we posited that modelling the special needs status flag would likely serve to confound, not enrich, the results.

Because family-level socioeconomic status (SES) data were unavailable, we utilised 2002 *median equivalised disposable income (MEDI)* from the Canada Revenue Agency (supplied to us from Statistics Canada) as a proxy for family-level SES. A similar approach to family-level SES was followed by Lloyd and Hertzman (2008), McGrail (2007), and Oliver, Dunn, Kohen, and Hertzman (2007).

This measure requires identifying the six-character home postal code for each of the children. For each postal code, a disposable income per equivalised person is then calculated. Next, the postal codes are ranked by this income, and then 1000 geography income bands, each containing approximately 1400 families and 3700 individuals, are created. Computed in this fashion, the MEDI is a rank measure of income for each geographic income band. Equivalisation (i.e., adjusting for family size) is meant to make incomes across families more comparable, taking into consideration that there are fixed costs of running a household, so that additional family members do not represent linear additions to cost (McGrail, 2007).

In *urban* areas, a single postal code can correspond variably to a block-face (one side of a city street between consecutive intersections), a community mailbox, an apartment building, a business building, a large firm/organisation, a federal government department, agency or branch, a mail delivery route (rural, suburban, or mobile), general delivery at a specific post office, or one of more post office boxes (Statistics Canada, 2008). In contrast, *rural* postal codes are defined in terms of rural routes which are not explicitly attached to dwellings as are civic address ranges. These routes tend to straddle several dissemination areas, often crossing boundaries of standard geographic areas such as census tracts or census subdivisions. Therefore, the MEDI is likely a better proxy for family-level income in urban rather than rural areas; as is described in later sections, however, the MEDI was the only way in which we could attempt to control for family income.

Neighbourhood-Level Predictor: Index of Concentration at the Extremes (ICE)

When exploring the influence of neighbourhood concentration of affluence or disadvantage on health or developmental outcomes, researchers often face problems associated with multicollinearity. This multicollinearity is often encountered because proportions of affluent or disadvantaged families tend to be highly correlated across neighbourhoods (Casciano & Massey, 2008). It is for this reason that Massey (2001) instead recommends conceptualising the concentrations of affluence and disadvantage as falling along a *single* continuum, ranging from a negative extreme (where all families are disadvantaged) to a neutral point (where affluent and disadvantaged families are equally balanced) to a positive extreme (where all families are affluent). In addition to offering a way to overcome issues of collinearity, another advantage of using such a continuum—versus separate measures of concentrated affluence and concentrated disadvantage—is that it facilitates the examination of outcomes when the number of affluent and poor residents in a neighbourhood is relatively equal (Casciano & Massey, 2008).

To measure neighbourhood-level variation along this continuum, Massey (2001) proposes using the *Index of Concentration at the Extremes (ICE)*, which is calculated as described in Equation 1:

$$ICE_j = (A_j - P_j)/T_j \quad (1)$$

where:

A_j = count of families or persons classified as affluent in neighbourhood j;
P_j = count of families or persons classified as disadvantaged in neighbourhood j;
T_j = total population of neighbourhood j for whom there is income data available.

Theoretically, ICE scores can range from a minimum of −1.0 ("absolute concentrated disadvantage") to a theoretical maximum of +1.0 ("absolute concentrated affluence"). An ICE score of zero suggests that a given neighbourhood is comprised equally of affluent and disadvantaged families. This measure has been validated previously (see Casciano & Massey, 2008) and has been used in prior studies (e.g., see Kubrin & Stewart, 2006; Morenoff, Sampson, & Raudenbush, 2001). We used Statistics Canada's 2001 *% affluent families* (*Income* ≥ $100,000) and *% living below the low income cut-off* to create a neighbourhood-level ICE. We refer to this particular ICE as being income-based (hereafter ICE_{Income}) in order to distinguish it from an education-based ICE control variable (hereafter $ICE_{Education}$), which we describe in a later section. Empirically, the ICE_{Income} scores ranged from −0.61 to +0.47 ($M = -0.01$, $SD = 0.14$) in our study population of 433 neighbourhoods (see Table 2).

Our census data holdings contained only one measure of neighbourhood disadvantage (*% living below the low income cut-off*), a variable that pertains to the total population of the neighbourhood. In terms of affluence measures, however, we had the choice of three variables: one that pertains to families (*% affluent families*, *Income* ≥ $100,000) and two which pertain to the total population (*% affluent males*, *Income* > $60,000 and *% affluent females*, *Income* > $60,000). We opted to compute the neighbourhood ICEIncome scores presented herein using the *family-based* affluence measure because we posited that this specific variable would be the most directly relevant to the study population of Kindergarten children. To ensure, however, that our using the *total population-based* disadvantage measure and the *family-based* affluence measure did not affect negatively interpretation of our ICE results, we then compared the correlation between ICE Income scores computed as described above to ICE Income scores computed using the total population-based disadvantage measure and the sum of the two total population-based affluence measures. The scores were nearly perfectly correlated ($r = .97$, $p = .000$).

Neighbourhood-Level Controls

We include three sets of neighbourhood-level control variables: educational heterogeneity, cultural heterogeneity, and residential instability. Each is described in this section and their descriptive statistics are reported in Table 2.

Blau (1977) and Fitzpatrick and Hwang (1992), among others, note that one particular condition affecting the opportunity for inter-group relations is *heterogeneity*, a consequence of people being distributed along a parameter such as race or ethnicity. Blau (1977) argues that levels of group heterogeneity experience differing dynamics and organisational outcomes. Within more homogeneous groups, members tend to communicate with one another more often and in a greater variety of ways, not just because of the frequency of contact with similar others, but also perhaps because they share worldviews and a unified culture (Earley & Mosakowski, 2000). As group heterogeneity increases, however, social differentiation occurs, which has implications for unequal social interactions (Blau, 1977).

Educational heterogeneity. Once again guided by Massey's (2001) rationale for using the ICE to measure the correlated measures of concentrated affluence and disadvantage, we used Statistics Canada's 2001 *% with university degree* and *% not graduating from high school* to create a neighbourhood-level ICE ($ICE_{Education}$) in order to control for educational heterogeneity. Examination of the distribution of $ICE_{Education}$ scores suggested higher proportions of lower-educated persons than of higher-educated persons. A similar ICE score for education has been used in prior research on neighbourhood context and body mass index (see Do et al., 2007).

Cultural heterogeneity. Prior theoretical and empirical research has suggested how neighbourhood ethnic and cultural heterogeneity has implications for a variety of collective and individual outcomes (e.g., Harding, 2007; Sampson & Groves, 1989). We use two of the few cultural-related variables to which we had access in the

Table 2
Descriptive statistics: continuous variables.

	N	Mean	*SD*	Minimum	Maximum
Child outcome					
EDI physical scale	37,455	8.61	1.18	0.38	10
EDI social scale	37,503	8.21	1.82	0.0	10
EDI emotional scale	37,059	7.98	1.57	0.5	10
EDI language scale	37,115	8.14	1.95	0.0	10
EDI communications scale	37,518	7.47	2.13	0.0	10
EDI total score	36,981	40.57	6.93	3.8	50
Neighbourhood predictor					
Index of Concentration at the $Extremes_{Income}$	433	−0.01	0.14	−0.61	0.47
Neighbourhood controls					
Index of Concentration at the $Extremes_{Education}$	433	−0.11	0.17	−0.39	0.68
% Non-official language as a mother tongue	433	20.42	16.5	3.88	77.5
% Reporting Aboriginal identity	433	5.07	6.89	0.0	61.17
% Moved in last year	433	15.98	5.03	5.05	35.91
Child control					
Median equivalised disposable income	37,798	23,240.18	7378.94	2300	62,700

Note. Each EDI scale's scores ranges from 0 to 10. The total EDI score ranges from 0 to 50.

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Statistics Canada 2001 database – *% non-official language as a mother tongue* and *% reporting Aboriginal identity* – as our neighbourhood-level cultural heterogeneity controls.

Residential instability. Neighbourhoods' *residential stability* has been linked to better health outcomes for affluent and disadvantaged residents alike. Reasons for such findings are that neighbourhoods are important sites for the formation and development of social ties and the fostering of a sense of connectedness. Bures (2003) observes that:

> *residential stability may increase children's community-based "social capital"—their connections to social and institutional networks—by giving them the opportunity to develop strong social and community ties. Strong social networks in childhood may carry over to adulthood, indirectly influencing an adult's ability to establish supportive social networks* (p. 1144).

Because disadvantage is often associated with increased residential instability, we also controlled for the effect of instability in our models by using Statistics Canada's 2001 *% that moved in last year* in our models.

Analytic Strategy

Recall from earlier sections and from Fig. 1 that we set out to test two competing hypotheses of the relationship between neighbourhood socioeconomic composition and child development: the linear *Benefits of Affluent Neighbours for Development (BAND)* hypothesis (Hypothesis 1) and the curvilinear *Competition* hypothesis (Hypothesis 2). To test the two hypotheses, we ran three separate models, each of which is described in this section. In all analyses, we utilised Hierarchical Linear Modelling (HLM) software, version 6.06 (Raudenbush, Bryk, Cheong, & Congdon, 2004).

Model 1: At the child level (Equation 2a), EDI scores (EDI_{ij}) were characterised as the sum of an intercept (b_{0j}), five slope terms (b_{1j}, b_{2j}, b_{3j}, b_{4j}, and b_{5j}), and a random error term (r_{ij}). At the neighbourhood level (Equation 2b), $\text{ICE}_{\text{Income}}$ scores were included in the model. The respective slopes for child gender, Aboriginal status, ESL status, median equivalised disposable income, and EDI year were fixed (i.e., their respective effects were constrained to be constant across neighbourhoods). This model served as our baseline.

$$\begin{aligned}\textit{Child level}:\ EDI_{ij} &= b_{0j} + b_{1j}(\textit{Gender}_{ij}) + b_{2j}(\textit{Aboriginal status}_{ij}) + b_{3j}\\ &(\textit{ESL status}_{ij}) + b_{4j}(\textit{Median equivalised disposable income}_{ij})\\ &+ b_{5j}(\textit{EDI year}_{ij}) + r_{ij}, \quad \text{where } r_{ij}\sim N(0,\sigma^2) \end{aligned} \tag{2a}$$

$$\begin{aligned}\textit{Neighbourhood level}:\ b_{0j} &= \gamma_{00} + \gamma_{01}(\textit{Index of Concentration at the Extremes}_{\textit{Incomej}}) + u_{0j}\\ b_{1j} &= \gamma_{10}\\ b_{2j} &= \gamma_{20}\\ b_{3j} &= \gamma_{30}\\ b_{4j} &= \gamma_{40}\\ b_{5j} &= \gamma_{50}\end{aligned} \tag{2b}$$

Model 2: At the child level (Equation 3a), EDI scores (EDI_{ij}) were once again characterised as the sum of an intercept, five slope terms, and a random error term. At the neighbourhood level (Equation 3b), $\text{ICE}_{\text{Income}}$, $\text{ICE}_{\text{Education}}$, both cultural heterogeneity controls, and the residential stability control were included in the model. Once again, the respective slopes for child gender, Aboriginal status, ESL status, median equivalised disposable income, and EDI year were fixed. This model was designed to test the linear *Benefits of Affluent Neighbours for Development (BAND)* hypothesis (Hypothesis 1).

$$\textit{Child level}:\ \text{As described in Equation (2a)} \tag{3a}$$

$$\begin{aligned}\textit{Neighbourhood level}:\ b_{0j} &= \gamma_{00} + \gamma_{01}(\textit{Index of Concentration at the Extremes}_{\textit{Incomej}}) + \gamma_{02}(\textit{Index of}\\ &\textit{Concentration at the Extremes}_{\textit{Educationj}}) + \gamma_{03}\\ &(\textit{\%Non}-\textit{official language as a mother tongue}_j)\\ &+\gamma_{04}(\textit{\% Reporting Aboriginal identity}_j) + \gamma_{05}\\ &(\textit{\%Moved in last year}_j) + u_{0j}\\ b_{1j} &= \gamma_{10}\\ b_{2j} &= \gamma_{20}\\ b_{3j} &= \gamma_{30}\\ b_{4j} &= \gamma_{40}\\ b_{5j} &= \gamma_{50}\end{aligned} \tag{3b}$$

Model 3: We specified Model 3 to include the same variables as Model 2 but with the addition of the $\text{ICE}^2_{\text{Income}}$ variable. In computing this polynomial term, we first grand-mean centred the $\text{ICE}_{\text{Income}}$ scores and then squared the centred scores, as per the recommendations of Cohen, Cohen, West, and Aiken (2003). Once again, the respective slopes for child gender, Aboriginal status, ESL status, median equivalised disposable income, and EDI year were fixed. This model, and in particular the inclusion of $\text{ICE}^2_{\text{Income}}$, was designed to test the curvilinear *competition* hypothesis (Hypothesis 2).

$$\textit{Child level}:\ \text{As described in Equation (2a)} \tag{4a}$$

$$\begin{aligned}\textit{Neighbourhood level}:\ b_{0j} &= \gamma_{00} + \gamma_{01}(\textit{Index of Concentration at the Extremes}_{\textit{Incomej}}) + \gamma_{02}(\textit{Index of}\\ &\textit{Concentration at the Extremes}_{\textit{Incomej}})^{2\dagger} + \gamma_{03}\\ &(\textit{Index of Concentration at the Extremes}_{\textit{Educationj}})\\ &+\gamma_{04}(\textit{\% Non}-\textit{official language as a mother}\\ &\textit{tongue}_j) + \gamma_{05}(\textit{\% Reporting Aboriginal}\\ &\textit{identity}_j) + \gamma_{06}(\textit{\% Moved in last year}_j) + u_{0j}\\ b_{1j} &= \gamma_{10}\\ b_{2j} &= \gamma_{20}\\ b_{3j} &= \gamma_{30}\\ b_{4j} &= \gamma_{40}\\ b_{5j} &= \gamma_{50}\end{aligned} \tag{4b}$$

where † indicates that the variable's scores have been grand-mean centred and then squared.

Each of the three models was designed as a one-way analysis of covariance with random effects, which is a class of random intercept models. The key feature of random intercept models is that only the intercept parameter (b_{0j}) in the child-level model is assumed to vary at the level of the neighbourhood. Raudenbush and Bryk (2002) recommend this type of analysis when the key predictor of interest is at the higher level (in this case, neighbourhood-level $\text{ICE}_{\text{Income}}$ scores) but the outcome variable is measured at the lower level (in this case, child-level EDI scores). Lapointe et al. (2007) and Lloyd and Hertzman (2008) adopted a similar analytic strategy in their study exploring the influence of neighbourhood characteristics on EDI scores.

Furthermore, when conducting a multi-level analysis, one is generally interested in the fixed coefficients. Inferences about these fixed coefficients depend on the distribution of random effects of each level of the hierarchy. According to Raudenbush and Bryk (2002), robust standard errors are often computed in order to check the sensitivity to inferences about fixed effects to these assumptions about the random effects, and are used when the number of higher-level units is large. Given that we studied several hundred neighbourhood units in this paper ($N_{Neighbourhoods} = 433$), we report estimates of fixed effects with robust standard errors.

We found that children's EDI scores were statistically-significantly negatively skewed. Lloyd and Hertzman (2008) found that, after having run each of their multi-level analyses using original EDI scores and EDI scores that had been reflect-and-inverse transformed, results based on the transformed EDI scores were virtually identical to those based on the original EDI scores. For reasons of interpretability, we therefore use original EDI scores in our analyses.

In regards to modelling urban–rural differences, a recent paper describing multi-level analyses of neighbourhood ICE scores on child-level EDI outcomes revealed no statistically significant urban/rural differences in the ICE regression coefficients, after controlling for the same child-level covariates utilised in the current study (Lloyd & Hertzman, 2008). These analyses provide empirical justification for our having collapsed in our analyses the records of children who resided in either urban or rural neighbourhoods.

Table 2 presents the means, standard deviations, minimum scores, and maximum scores for each of the continuous child- and neighbourhood-level variables. Table 3 describes the correlations among the four neighbourhood-level variables. Notable correlations include a moderately strong relationship between neighbourhoods' ICE_{Income} scores and *% Moved in last year* ($r = -.500$, $p \le .01$), suggesting that as neighbourhood-level affluence increases, residential instability decreases. Also noteworthy is the moderately strong relationship between neighbourhoods' ICE_{Income} and $ICE_{Education}$ ($r = .545$, $p \le .01$), suggesting that as concentrated affluence increases, so too does neighbourhood-level education. Examination of the correlation matrix provided no evidence of multicollinearity among the neighbourhood-level variables' scores. Hence, not only from a theoretical but also a statistical point of view, we included all four predictor variables in the six multi-level analyses described in the next section.

Results

Table 4 lists the results from our multi-level models as they pertain to our hypotheses. Because our primary objective was simply to explore the nature of the relationship between neighbourhood-level socioeconomic characteristics and child-level outcomes, we interpret only the coefficients typed in bold face in Table 4.

Model 1: Baseline

Across EDI scales, results indicated that neighbourhood-level Index of Concentration at the Extremes for Income (ICE_{Income}) scores significantly predicted children's EDI scores, controlling for various child-level covariates. In particular, we found that for every one unit increase in ICE_{Income}, there was between a 0.39 (physical) and 0.67 (language) unit increase in EDI scores. In terms of the EDI total score, there was an increase of 2.23 for every one unit increase in ICE_{Income}. Taken together, these findings suggest that, as the concentration of affluence in a given neighbourhood increases, so too does the development of its Kindergarten children – across the broad range of developmental domains.

Table 3
Correlations among the neighbourhood-level variables.

	1	2	3	4
1. Index Concentration at the $Extremes_{Income}$				
2. Index of Concentration at the $Extremes_{Education}$	.545**			
3. % Non-official language as a mother tongue	−.261**	.220**		
4. % Reporting Aboriginal identity	−.183**	−.405**	−.307**	
5. % Moved in last year	−.500**	−.037	.066	.155**

**$p \le .01$.

Model 2: Benefits of Affluent Neighbours for Development (BAND) Hypothesis

Across EDI scales, results once again indicated that neighbourhood-level ICE_{Income} scores significantly predicted children's EDI scores, this time controlling for various child-level and neighbourhood-level covariates. In particular, we found that for every one unit increase in ICE_{Income}, there was between a 0.42 (physical) and 0.88 (communications) unit increase in EDI scores. In terms of the EDI total score, there was an increase of 2.57 for every one unit increase in ICE_{Income}. These findings suggest once again that, as the concentration of affluence in a given neighbourhood increases, so too does the development of its Kindergarten children.

Model 3: Competition Hypothesis

Recall from an earlier section that we included a polynomial term (ICE^2_{Income}) in Model 3, so as to assess whether or not the relationship between neighbourhood-level ICE_{Income} and children's EDI scores was curvilinear, once again controlling for various child- and neighbourhood-level covariates. We discovered that, in five of the six instances (the physical, social, emotional, and communication scales, as well as the total score), the coefficient for ICE^2_{Income} was statistically significant. In terms of the language scale, however, results indicated that ICE^2_{Income} did not make any statistically-meaningful contribution to the model ($\gamma = -0.64$, $p > .05$), suggesting that the relationship between ICE_{Income} and children's language development is instead linear, and thus consistent with the Benefits of Affluent Neighbours for Development (BAND) hypothesis.

Equipped with evidence suggesting a *curvilinear* relationship between ICE_{Income} and children's physical, social, emotional, communications, and total scores, and a *linear* relationship between ICE_{Income} and children's language scores, we produced graphs depicting each of these relationships. Fig. 2a–d plots the predicted EDI scores at different values of the ICE_{income} by using the equation for Model 3 (for physical, social, emotional, communication, and total scores) and Model 2 (for language scores) with all variables other than ICE_{Income} and ICE^2_{Income} held constant at their mean.

Earlier, we posited that, if competition does indeed have deleterious effects on individuals' outcomes, then one would expect to see a u-shaped relationship indicating that child development outcomes *improve* as neighbourhood socioeconomic composition becomes increasingly more *homogeneous*. Instead, the relationship between ICE_{Income} and children's physical, social, emotional, communication, and total scores – while indeed curvilinear – follows a different direction: children's physical, social, emotional, communications, and total scores *improved* as neighbourhood socioeconomic composition became increasingly more *heterogeneous*.

Table 5 describes average differences in EDI scores between neighbourhoods with $ICE_{Income} = 0.0$ (i.e., "mixed-income neighbourhoods" in which there were relatively *equal proportions* of affluent and disadvantaged neighbours), neighbourhoods with

Table 4
Results of multi-level linear models of Early Development Instrument (EDI) scores regressed on neighbourhood-level conditions and child-level sociodemographic factors.

	Physical health and well-being ($N_{Children} = 37{,}455$; $N_{Neighbourhoods} = 433$)			Social knowledge and competence ($N_{Children} = 37{,}503$; $N_{Neighbourhoods} = 433$)		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Neighbourhood-level variables						
Index of Concentration at the Extremes$_{Income}$	**0.39 (0.09)****	**0.42 (0.15)****	**0.41 (0.14)****	**0.40 (0.14)****	**0.52 (0.22)***	**0.51 (0.21)***
Index of Concentration at the Extremes$^2_{Income}$			**−1.12 (0.37)****			**−1.67 (0.49)****
Index of Concentration at the Extremes$_{Education}$		0.06 (0.12)	0.11 (0.12)		−0.24 (0.17)	−0.16 (0.17)
% Non-official language as a mother tongue		0.00 (0.00)**	0.00 (0.00)**		0.00 (0.00)	0.00 (0.00)†
% Reporting Aboriginal identity		−0.00 (0.00)	−0.00 (0.00)		−0.00 (0.00)	−0.00 (0.00)
% Moved in last year		−0.00 (0.00)	−0.00 (0.00)		−0.00 (0.00)	−0.00 (0.00)
Child-level variables						
Gender (male = 1)	−0.33 (0.01)**	−0.33 (0.01)**	−0.33 (0.01)**	−0.77 (0.01)**	−0.77 (0.01)**	−0.77 (0.01)**
Aboriginal status = 1	−0.58 (0.02)**	−0.57 (0.04)**	−0.57 (0.04)**	−0.69 (0.03)**	−0.69 (0.05)**	−0.69 (0.05)**
English as second language = 1	0.02 (0.02)	0.01 (0.02)	0.01 (0.02)	−0.32 (0.03)**	−0.32 (0.03)**	−0.32 (0.03)**
Median equivalised disposable income	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**
EDI year	0.05 (0.02)**	0.04 (0.02)†	0.05 (0.02)†	0.02 (0.02)	0.03 (0.03)	0.03 (0.03)
Intercept	−111.03 (49.68)*	−86.41 (50.37)†	−89.05 (50.11)†	−50.39 (62.90)	−54.72 (65.11)	−59.35 (64.52)
Intercept variance component (u_{0j})	0.06	0.05	0.05	0.11	0.11	0.11
Chi-square (degrees of freedom)	2419.13 (431)**	2033.66 (427)**	1989.61 (426)**	1792.52 (431)**	1757.67 (427)**	1727.98 (426)**
Level 1 variance component (r_{ij})	1.24	1.24	1.24	2.96	2.96	2.96

	Emotional health and maturity ($N_{Children} = 37{,}059$; $N_{Neighbourhoods} = 433$)			Language and cognitive development ($N_{Children} = 37{,}115$; $N_{Neighbourhoods} = 433$)		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Neighbourhood-level variables						
Index of Concentration at the Extremes$_{Income}$	**0.44 (0.13)****	**0.65 (0.19)****	**0.63 (0.18)****	**0.67 (0.15)****	**0.59 (0.24)***	**0.58 (0.24)***
Index of Concentration at the Extremes$^2_{Income}$			**−1.54 (0.44)****			**−0.64 (0.63)**
Index of Concentration at the Extremes$_{Education}$		−0.22 (0.15)	−0.14 (0.15)		0.17 (0.18)	0.21 (0.19)
% Non-official language as a mother tongue		0.00 (0.00)**	0.00 (0.00)**		0.00 (0.00)**	0.00 (0.00)**
% Reporting Aboriginal identity		0.00 (0.00)	0.00 (0.00)		0.00 (0.00)	0.00 (0.00)
% Moved in last year		−0.00 (0.00)	−0.00 (0.00)		−0.00 (0.00)	−0.00 (0.00)
Child-level variables						
Gender (male = 1)	−0.78 (0.01)**	−0.78 (0.01)**	−0.78 (0.01)**	−0.56 (0.02)**	−0.56 (0.02)**	−0.56 (0.02)**
Aboriginal status = 1	−0.51 (0.04)**	−0.51 (0.04)**	−0.51 (0.04)**	−0.90 (0.06)**	−0.89 (0.06)**	−0.89 (0.06)**
English as second language = 1	−0.17 (0.03)**	−0.18 (0.03)**	−0.18 (0.03)**	−0.62 (0.04)**	−0.64 (0.04)**	−0.64 (0.04)**
Median equivalised disposable income	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**
EDI year	−0.05 (0.02)*	−0.05 (0.03)†	−0.05 (0.02)†	0.11 (0.03)**	0.10 (0.03)**	0.10 (0.03)**
Intercept	118.05 (58.90)*	126.07 (60.65)*	121.76 (60.07)*	−226.49 (71.72)**	−199.83 (73.05)**	−201.52 (73.11)**
Intercept variance component (u_{0j})	0.09	0.09	0.08	0.16	0.16	0.16
Chi-square (degrees of freedom)	1950.23 (431)**	1912.95 (427)**	1874.26 (426)**	2195.02 (431)**	2107.81 (427)**	2100.68 (426)**
Level 1 variance component (r_{ij})	2.15	2.15	2.15	3.39	3.39	3.39

	Communications skills and general knowledge ($N_{Children} = 37{,}518$; $N_{Neighbourhoods} = 433$)			Total score ($N_{Children} = 36{,}981$; $N_{Neighbourhoods} = 433$)		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Neighbourhood-level variables						
Index of Concentration at the Extremes$_{Income}$	**0.44 (0.20)***	**0.88 (0.31)****	**0.86 (0.28)****	**2.23 (0.60)****	**2.57 (0.89)****	**2.51 (0.84)****
Index of Concentration at the Extremes$^2_{Income}$			**−2.29 (1.15)***			**−6.82 (2.27)****
Index of Concentration at the Extremes$_{Education}$		−0.00 (0.21)	0.11 (0.21)		0.05 (0.67)	0.40 (0.67)
% Non-official language as a mother tongue		0.01 (0.00)**	0.01 (0.00)**		0.02 (0.00)**	0.02 (0.00)**
% Reporting Aboriginal identity		−0.00 (0.00)	−0.00 (0.00)		−0.00 (0.01)	−0.00 (0.01)
% Moved in last year		0.00 (0.00)	0.00 (0.00)		−0.01 (0.02)	−0.01 (0.01)
Child-level variables						
Gender (male = 1)	−0.57 (0.01)**	−0.57 (0.01)**	−0.57 (0.01)**	−2.97 (0.06)**	−2.97 (0.06)**	−2.97 (0.06)**
Aboriginal status = 1	−0.91 (0.05)**	−0.89 (0.05)**	−0.89 (0.05)**	−3.46 (0.21)**	−3.43 (0.21)**	−3.42 (0.21)**
English as second language = 1	−2.16 (0.05)**	−2.21 (0.05)**	−2.21 (0.05)**	−3.27 (0.15)**	−3.38 (0.15)**	−3.37 (0.15)**
Median equivalised disposable income	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**
EDI year	0.13 (0.04)**	0.10 (0.04)*	0.10 (0.04)*	0.22 (0.12)†	0.15 (0.13)	0.16 (0.12)
Intercept	−261.64 (90.24)**	−195.81 (88.46)*	−200.98 (87.49)*	−403.72 (255.73)	−279.30 (260.84)	−296.32 (258.61)
Intercept variance component (u_{0j})	0.20	0.17	0.17	1.97	1.86	1.82
Chi-square (degrees of freedom)	2547.77 (431)**	2179.18 (427)**	2131.37 (426)**	2162.866 (431)**	2032.63 (427)**	1989.13 (426)**
Level 1 variance component (r_{ij})	3.57	3.57	3.57	40.41	40.40	40.41

$^{\dagger}p \le .10$; $^{*}p \le .05$; $^{**}p \le .01$.
All models rely on robust standard errors, as per the recommendations of Raudenbush and Bryk (2002).
Standard errors in parentheses.
For readability, all values rounded to nearest hundredth.
Each EDI scale's scores ranges from 0 to 10. The total EDI score ranges from 0 to 50.

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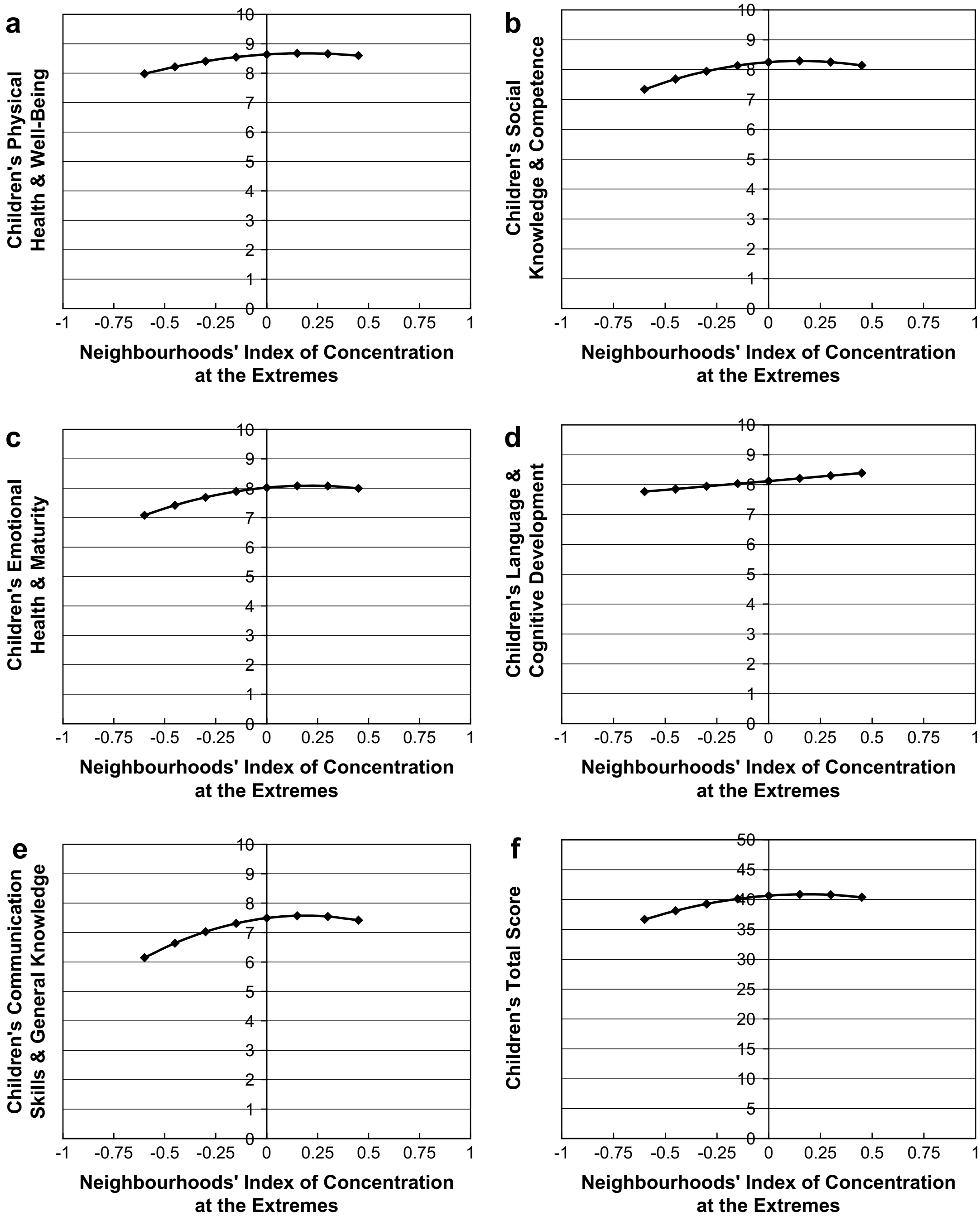

Fig. 2. a–f. Relationship between neighbourhoods' Index of Concentration at the Extremes$_{\text{Income}}$ and children's EDI scores, after controlling for the covariates.

$ICE_{Income} = -0.61$ (i.e., having the most concentrated disadvantage) and neighbourhoods with $ICE_{Income} = +0.47$ (i.e., having the most concentrated affluence). Children's physical, social, emotional, and communication scores were, on average, 0.96 points higher in mixed-income neighbourhoods than in neighbourhoods with the most concentrated disadvantage and 0.06 points higher than in neighbourhoods with the most concentrated affluence. This effect is particularly pronounced for the communication skills and general knowledge scale: in mixed-income neighbourhoods, children's scores were, respectively, 1.35 and 0.08 points higher than in neighbourhoods with the most concentrated disadvantage and the most concentrated affluence. This finding is consistent with Oliver et al. (2007) who observe that "stronger neighbourhood effects have typically been found for cognitive outcomes than for behavioural and social outcomes of young children" (p. 849).

In terms of the total score, there was an average difference of 3.97 points between mixed-income neighbourhoods and neighbourhoods with the most concentrated disadvantage and an average difference of 0.25 points between neighbourhoods of mixed income and neighbourhoods with the most concentrated affluence. These average differences are in contrast to the findings for the language scale, wherein EDI scores were on average 0.36 points higher in mixed-income neighbourhoods versus neighbourhoods with the most concentrated disadvantage and, in turn, 0.26 points higher in neighbourhoods with the most concentrated affluence versus mixed-income neighbourhoods.

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Table 5
Average differences in EDI scores between neighbourhoods with the most concentrated disadvantage ($ICE_{Income} = -0.61$), equal proportions of affluence and disadvantage ($ICE_{Income} = 0$), and the most concentrated affluence ($ICE_{Income} = +0.47$).

	Average EDI score			Difference	Mean difference
	$ICE_{Income} = -0.61$	$ICE_{Income} = 0.00$			
BAND hypothesis					
Language	7.76	8.12		0.36	0.36
Competition hypothesis					
Physical	7.97	8.63		0.66	0.96
Social	7.34	8.25		0.91	
Emotional	7.08	8.02		0.94	
Communication	6.14	7.49		1.35	
Total	36.67	40.64		3.97	3.97
		$ICE_{Income} = 0.00$	$ICE_{Income} = +0.47$		
BAND hypothesis					
Language		8.12	8.38	0.26	0.26
Competition hypothesis					
Physical		8.63	8.59	0.04	0.06
Social		8.25	8.14	0.11	
Emotional		8.02	7.99	0.03	
Communication		7.49	7.41	0.08	
Total		40.64	40.39	0.25	0.25

Note 1. Each EDI scale's scores ranges from 0 to 10. The total EDI score ranges from 0 to 50.
Note 2. Although the ICE_{Income} can range theoretically from −1.0 to +1.0, empirically it ranged from −0.61 to 0.47 in our study population of 433 neighbourhoods.

Discussion

The purpose of the current study was to utilise a previously-validated composite measure of neighbourhood socioeconomic composition—*Index of Concentration at the Extremes* (Massey, 2001)—to test the relationship between concentrated affluence and disadvantage and children's health and developmental outcomes, as measured by the *Early Development Instrument (EDI)*—a holistic measure of Kindergarten children's readiness for school.

Drawing upon prior theoretical assertions about the pathways linking neighbourhood socioeconomic composition and individual-level outcomes, we proposed two competing hypotheses: one that argued that increased affluence was beneficial for child development outcomes (i.e., the Benefits of Affluent Neighbours for Development or BAND hypothesis) and another that argued that increased affluence may be associated with lower child development outcomes due to competition for scarce resources and relative deprivation (i.e., the Competition hypothesis). Our collective findings do not support the Competition hypothesis. Although we found evidence for the BAND hypothesis with respect to language and cognitive development, the majority of our findings demonstrate curvilinear relationships that are not wholly consistent with the BAND hypothesis and thus warrant further theoretical consideration. In four of five EDI scales and the total EDI score, increasing concentrations of affluence were associated with higher EDI scores initially and then flattened and reversed direction soon after the ICE turned positive (indicating higher proportions of affluent residents). Thus, for these outcomes, the neighbourhoods with the highest levels of concentrated affluence were not found to have the highest EDI scores. Rather, higher EDI scores were found in neighbourhoods with more *heterogeneity* in their socioeconomic composition.

Proposed Explanations

What explanation could be proposed to explain such results? In light of our findings, we propose two related theories that consider how such heterogeneous, mixed-income neighbourhoods may benefit all of its resident children (and not just children from either affluent or poor families).

First, these findings suggest that children residing in mixed-income neighbourhoods may benefit not only from the presence of affluent residents in terms of collective socialisation (e.g., Kohen et al., 1998), but also the presence of services and institutions aimed at assisting lower-income residents. Thus, we propose that such neighbourhoods may possess a wider variety of services and amenities than neighbourhoods with higher concentrations of affluent or poor families. These services and amenities may, in turn, be beneficial in serving the needs of a wider range of families and children. In addition to such neighbourhood environments being better able to contribute to meeting the needs of a more diverse population, the families who reside in such mixed-income locations may ultimately benefit from the multitude of services and amenities being provided, regardless of their own particular family background and needs.

Second, mixed-income neighbourhoods may also have more resources at their disposal via greater community social capital (i.e., political, cultural, and economic resources embedded in social relations either within or outside the community) (Carpiano, 2006). The presence of wealthy residents living in mixed-income neighbourhoods (rather than in more exclusive 'gated communities') may indicate the willingness of affluent, influential residents to invest in public institutions, rather than opting out for private services instead.

Taken together, these two overlapping explanations motivated from our findings suggest the need to consider an "anti-competition" hypothesis for neighbourhood socioeconomic composition and child development—that increased community diversity may create the opportunity for a wide range of residents to invest in the community which, in turn, benefits the development of its young children. This anti-competition hypothesis necessitates consideration of issues related to socioeconomic integration as they pertain to social policies and development planning (e.g., Anderson et al., 2003; Brophy & Smith, 1997; Qadeer, 1997). To be certain, further investigation is necessary to better evaluate the role of these (and other) theorised contextual mechanisms that may be operating to produce such patterns.

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Strengths

The current study has several strengths. First, by focussing this research on population-based data – some of the most comprehensive population-based early child development data in Canada – we overcome various problems outlined by Kershaw, Forer, Irwin, Hertzman, and Lapointe (2007) that commonly afflict studies of ECD. These problems can include the tendency to rely on small samples of children, to focus solely on high-risk populations, to use administratively-defined census neighbourhood boundaries, and to attend only to select developmental domains.

A second strength of this paper is that we took a multi-level approach to exploring the relationship between young children and their residential environments. Not only do such methods allow for more reliable estimation of neighbourhood effects, but also they make it possible to separate out neighbourhood-level effects from child-level effects. As Oliver et al. (2007) observe, the majority of neighbourhood effects studies have focussed on the health and developmental outcomes of older children and adults. A comparatively smaller literature, however, has explored the extent to which young children – in particular, those aged five years or younger – are influenced by the neighbourhoods in which they reside. Fewer still are studies that take a multi-level approach to exploring this relationship. As noted by Sellström and Bremberg (2006), such knowledge gained from multi-level approaches, "can be of great importance when designing preventive interventions aimed at social groups that possess limited resources" (p. 545).

Third, we utilised a previously-validated measure of neighbourhood socioeconomic composition – the *Index of Concentration at the Extremes (ICE)* – which not only allowed a more precise estimation of the competing influences of concentrated affluence and disadvantage, but also facilitated examination of early child development when neighbourhoods had equal proportions of affluent and disadvantaged families as well as the potential impact of neighbourhood-level income inequality.

Finally, and arguably most important, we took a theoretical and empirical-based approach to testing two competing hypotheses about the relationship between concentrated affluence and disadvantage and health and developmental outcomes. As Carpiano and Daley (2006) suggest, testing competing theories is a useful approach for better understanding what factors and mechanisms are at work in producing population health.

Limitations

In light of these strengths, our findings must also be considered with respect to certain limitations. First, we utilised 2002 *median equivalised disposable income* as a proxy for family-level SES, simply because family-level socioeconomic status data were unavailable to us. Although a similar approach was taken elsewhere (Lloyd & Hertzman, 2008; McGrail, 2007; Oliver et al., 2007), we acknowledge that there are inherent limitations in treating geography band level data as a proxy for family-level SES, particularly when one considers that the postal code-level SES data that comprise the geography bands can range from a block-face (in urban neighbourhoods) to a rural route which is not explicitly attached to dwellings (in rural neighbourhoods). Given the availability of the data, however, we thought it best to control for child-level SES in the only way we could. In this same vein, we also acknowledge the limitation of computing our ICE_{Income} scores from one year of census data. As a future direction, we intend to re-examine the relationship between ICE_{Income} and EDI scores when the next census year's (2006) data become available and, hence, possible trends over time can be considered.

A second limitation concerns potential problems related to selection bias. It is known that families reside in particular neighbourhoods through non-random assignment processes that are potentially confounded with the outcome measures (Oliver et al., 2007) and families have some degree of control about where they come to reside (Leventhal & Brooks-Gunn, 2003a). Nevertheless, the existing evidence-base on neighbourhood effects does suggest that neighbourhood environments can matter for shaping health and well-being (Harding, 2003). For example, in the *Moving to Opportunity (MTO)* randomised controlled trial, when families were relocated from high poverty neighbourhoods to near- or non-poor neighbourhoods, parents experienced significantly less distress than parents who remained in high poverty neighbourhoods (Leventhal & Brooks-Gunn, 2003b). Thus, possible interpretation problems notwithstanding, families – irrespective of why they come to live in a given neighbourhood – are potentially influenced by the socioeconomic characteristics of their neighbourhood environment. Nevertheless, it is important to recognise that simply because we found that heterogeneous, mixed-income neighbourhoods appear beneficial for child development does not necessarily imply that public policy and other initiatives designed to create socioeconomically heterogeneous neighbourhoods will "work" in the manners for which they were intended (Anderson et al., 2003; Brophy & Smith, 1997).

Also related to issues of potential selection bias is our exclusion of some neighbourhoods based on the number of children residing within them. As described above, data restrictions to protect confidentiality caused us to exclude a small proportion of neighbourhoods in BC, located in rural areas, so there may have been some under-representation of sparsely population rural areas. Considering that we lost only 4% of the child records, however, we contend that this data condition was by no means detrimental to the analyses presented herein.

A fourth limitation of the current study is that we were unable to control for a broader range of proximal-level factors – those child- or family-level variables that describe the more intimate environments in which children are reared – which can exert a strong, influence on the development of children (Duncan et al., 2007; Janus & Duku, 2007; Kershaw et al., 2005). The omission of such factors in neighbourhood effects research has been argued to potentially result in over-estimation of the influence of neighbourhood factors on individual-level outcomes (Ginther, Haveman, & Wolfe, 2000). The importance of such proximal factors notwithstanding, we argue that our inclusion of proximal-level factors (namely, gender, Aboriginal status, English as a second language status, and child-level SES proxy) were adequate in capturing some key elements of the family and parenting context, given that our primary objective was simply to explore the influence of concentrated affluence/disadvantage on children's development. Our inclusion of several neighbourhood-level controls is also a further effort to avoid overestimating the effect of ICE on EDI scores. Due to their respective correlations with neighbourhood ICE and EDI scores, these neighbourhood-level variables are also necessary for obtaining conservative estimates of ICE. Further, given the intervening family- and child-specific pathways through which neighbourhood factors might operate, it is likely that, by controlling for these child-level variables, our results may underestimate some of the effects of neighbourhood concentrated affluence/disadvantage (see Harding, 2003).

Despite the absence of some variables, however, our study utilised one of the most comprehensive and readily available population-based databases on ECD in North America. To be sure, measures of parental and family context would certainly have been ideal, but our database did not contain such information. It is important nevertheless to recognise that this study is quite unique

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in that it uses the largest population-based database in Canada to offer insights about populations that smaller samples (many of which examine a more limited range of communities and may thus overestimate family-level context) cannot provide. Hence, our study offers an important contribution to the existing research evidence-base on ECD, where it can be evaluated in tandem with or relative to other studies using different designs, measures, and samples.

Conclusions

Early child development constitutes an important determinant of health over the life course that is influenced by social and economic factors, including neighbourhood context (World Health Organization, 2007). By more fully understanding the nature of the relationship between neighbourhood-level socioeconomic characteristics and child development outcomes, population health researchers can investigate in a more focussed manner the mechanisms that connect variations in neighbourhoods' characteristics with the overall health and development of its young children. Such investigation provides an important step for informing interventions and policies for improving population health in Canada and elsewhere.

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