RESEARCH ARTICLE

Neighbourhood Income Inequality and General Psychopathology at 3-Years of Age

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Abstract

Background: Several studies have linked neighbourhood environment to preschool-aged children's behavioural problems. Income inequality is an identified risk factor for mental health among adolescents, however, little is known as to whether this relationship extends to younger children. **Objective:** To explore the association between neighbourhood-level income inequality and general psychopathology problems among preschool-aged children. **Methods:** We analyzed data from the All Our Families (AOF) longitudinal cohort located in Calgary, Canada at 3-years postpartum. The analytical sample consisted of 1615 mother-preschooler dyads nested within 184 neighbourhoods. Mothers completed the National Longitudinal Survey of Children and Youth Child Behaviour Checklist (NLSCY- CBCL), which assessed internalizing and externalizing symptoms. Income inequality was assessed via the Gini coefficient, which quantifies the unequal distribution of income in society. Mixed effects linear regression assessed the relationship between neighbourhood income inequality and preschooler's general psychopathology. **Results:** The mean Gini coefficient across the 184 neighbourhoods was 0.33 (SD = 0.05; min, max: 0.20-0.56). In the fully adjusted model income inequality was not associated with general psychopathology in children β = 0.07 (95%CI: -0.29, 0.45). Neighbourhood environment accounted for 0.5% of the variance in psychopathology in children. **Conclusion:** The lack of significant findings may be due to a lack of statistical power in the study. Future studies should investigate this relationship with appropriately powered studies, and over time, to assess if income inequality is a determinant of preschooler psychopathology in Canada.

Key Words: *income inequality, neighbourhoods, preschoolers, general psychopathology*

Résumé

Contexte: Plusieurs études ont relié l'environnement du quartier aux problèmes de comportement des enfants d'âge préscolaire. L'inégalité du revenu est un facteur de risque identifié pour la santé mentale chez les adolescents, pourtant, on ne sait pas encore si cette relation s'étend aux enfants plus jeunes. **Objectif:** Explorer l'association entre l'inégalité du revenu au niveau du quartier et les problèmes de psychopathologie générale chez les enfants d'âge préscolaire. **Méthodes:** Nous avons analysé les données de la cohorte longitudinale All Our Families (AOF) située à Calgary, Canada, à 3 ans de postpartum. L'échantillon analytique consistait en 1615 dyades mère-enfant d'âge préscolaire logées dans 184 quartiers. Les mères ont rempli l'Enquête longitudinale nationale sur les enfants et les jeunes et la liste de contrôle du

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comportement de l'enfant (ELNEJ- LCCE), qui évaluaient les symptômes d'internalisation et d'externalisation. L'inégalité du revenu était évaluée par le coefficient Gini, qui quantifie la distribution inégale du revenu dans la société. La régression linéaire à effets mixtes a évalué la relation entre l'inégalité du revenu du quartier et la psychopathologie générale de enfants d'âge préscolaire. **Résultats**: Le coefficient Gini moyen dans les 184 quartiers était de 0,33 (ET = 0,05; min, max : 0,20-0,56). Dans le modèle complétement ajusté, l'inégalité du revenu n'était pas associée à la psychopathologie générale des enfants β = 0,07 (IC à 95 % -0,29 à 0,45). L'environnement du quartier représentait 0,5 % de la variance de psychopathologie chez les enfants. **Conclusion:** L'absence de résultats significatifs peut être attribuable au manque de puissance statistique de l'étude. Les futures études devraient investiguer cette relation avec des études d'une puissance appropriée, et avec le temps, évaluer si l'inégalité du revenu est déterminante de la psychopathologie des enfants d'âge préscolaire au Canada.

Mots clés: *inégalité du revenu, quartiers, enfants d'âge préscolaire, psychopathologie générale*

Introduction

In Canadian samples, the prevalence of psychopathology problems is estimated to be 18-22%, among 4-11-year-old children (1). In other samples restricted to only the investigation of preschoolers (3-4 years of age), prevalence estimates of psychopathology problems range from 7-25% in several community samples (2). A known risk factor for child psychopathology is poverty (3). However, researchers who investigated the role of poverty on behavioural problems have seldom accounted for genetic factors. By not accounting for genetic or familial factors, spurious relationships may be observed. For example, researchers in Sweden observed a significant relationship between familial income and risk for future violent crime and substance misuse. However, this measure of association disappeared once they accounted for familial history (4).

Earned income, however, only represents one dimension of the income and health relationship, and does not explain how income is distributed in society, termed, income inequality (5). Income inequality is defined as the disproportionate distribution of income, or the gap between rich and poor in a geographical area such as a city, neighbourhood, or country (6), which has been identified as a determinant of normal development and health in a population (7).

Although limited research has been conducted, evidence consistently points to the adverse effects of income inequality on health among young children. For example, evidence from the USA suggests areas with greater income inequality have higher child maltreatment (8). Another study observed higher income inequality during early life (0-4 years) leads to more bullying perpetration and victimization in adolescences across 40 countries (9). Furthermore, a pooled analysis across 50 USA states determined that greater state-level income inequality was associated with mental health problems amongst children 0-17 years of age (10). Similarly, the long-term effect of income inequality at 4-5 years of age is associated with worse overall well-being in adolescence (11).

Unobserved familial risk factors among siblings, may also confound the relationship between area-level factors and health. For example, researchers in Sweden observed a complete attenuation in the association between neighbourhood deprivation and schizophrenia once unobserved familial risk factors was adjusted for in their analysis (12). Nonetheless, even a small percentage of variance in depression can be explained by area-level factors (12), which can present an opportunity to intervene at the population-level (13).

The process responsible for linking income inequality to poor health in children is yet to be fully understood. Possible mechanisms include erosion of social cohesion and an increase in status competition among parents (14). An erosion of social cohesion is characterized by areas with higher income inequality leading to greater mistrust between members of society, reduced social participation and social group membership (15). A lack of societal or community social cohesion may generate social isolation, alienation, and loneliness, leading to depression (16-18). In child studies, less social cohesion and low collective efficacy are associated with greater emotional or behavioural problems in children (19, 20).

Another mechanism by which income inequality leads to adverse health outcomes, is through increased status anxiety via stressful social comparisons between near equals in society, brought on by a sense of relative deprivation (21). Worrying about status and location within the status hierarchy can lead to more stress, feelings of inferiority, and

shame, and can lead to depression (21, 22). Evidence from the United States demonstrates that higher US state-level income inequality has also been linked with depression among women (23). Findings from another study among US mothers, observed state-level income inequality was associated with an increased likelihood of experiencing depression in low-income families (24). This relationship between income inequality and depression may be strikingly detrimental to maternal mental health which in turn might affect the health of their children. For example, maternal depressive symptoms are associated with the increased likelihood of preschooler psychopathology (25). Thus, it is plausible that preschool-aged children may experience the effects of inequality.

To our knowledge, no studies investigating neighbourhood income inequality and child psychopathology have been conducted. The current study will address the gaps in the literature by investigating neighbourhood income inequality and psychopathology using a sample of 1615 3-year-old children living in Calgary, Canada. We hypothesize that greater neighbourhood income inequality is associated with an increased likelihood for psychopathology problems in preschool-aged children.

Methods

Data source

The current study uses cross-sectional data at 3-years postpartum from the All Our Families (AOF) community-based pregnancy cohort located in Calgary, Canada. Further information on the AOF cohort has been published elsewhere (26, 27). Briefly, women were recruited from laboratory serology clinics, primary care clinics, or through posters/word of mouth. A total of 3387 women provided verbal consent and were enrolled at baseline between May 2008 to May 2011 and met the following inclusion criteria; women needed to be at least 18 years of age, be able to understand and speak English, be less than 25 weeks pregnant at recruitment date (26). The current study uses data at 3-years postpartum which included 69% (1993/3337) of mothers who started the study (26). To link the AOF cohort data to neighbourhoods and to analyze the contextual effects of neighbourhood income inequality, the first three digits of participants' postal codes were provided at baseline to AOF investigators and were used to reverse geocode each participant to one of 206 neighbourhoods in Calgary. When compared to the parenting population of Calgary, the AOF sample possesses higher incomes, however, education level and nativity status are similar to the Calgary parenting population (26).

A total of 8.8% (299/3337) were missing census data as they lived either in an undefined area, an area too new, or an industrial area, which may not have met the population threshold requirements, therefore, were dropped from the analysis. Using a test of two proportions, no differences were found in maternal ethnicity, education, household income level, or marital status in those excluded compared to those retained.

We imputed the mean for individual-level variables with missing data. The remaining 1.2% of participants with missing data for child sex were dropped from the analysis (40/3337). Due to very low missingness, multiple imputation was not feasible, and furthermore, missing data less than 5% has been hypothesized not to incur substantial bias (28). Again, using a test of two proportions, no differences were found in maternal ethnicity, education, household income level, or marital status in those excluded compared to those retained. This generated a dataset of n = 1615 mother-child dyads across n = 184 neighbourhoods in Calgary, Canada. Ethics approval for the study was granted from the University of Alberta Research Ethics Board under the study ID Pro00083081.

Income inequality

To generate the Gini coefficient, available data on after-tax household income classified into income bins (i.e., $30,000-$39,999 CAD) for Calgary dissemination areas was obtained from Statistics Canada for the 2006 census. Data from 2006 was used over earlier Census data due to availability. Next, a health geographer calculated the Gini coefficient using a previously established method (29). All computations for the Gini coefficient were completed in the R library using the binsmooth package (30).

The Gini coefficient is a unitless measure that has limits between and including 0 (indicates perfect equality) and 1 (indicates perfect inequality), and is based on the Lorenz curve, which plots the cumulative distribution function against a line of perfect equality (31). The interpretation indicates that the greater the value of the Gini coefficient, the greater the proportion of income held by few members within a defined area (31). The Gini coefficient was standardized using a Z-transformation, as it demonstrates meaningful interpretation (32).

Psychopathology

The outcome of interest was psychopathology in children, measured using the National Longitudinal Survey of Children and Youth adapted short form Child Behaviour Checklist (NLSCY-CBCL) (33), which was adapted from the original CBCL for the Canadian context (34). The

NLSCY-CBCL measures 2 global domains: internalizing (emotional/anxiety and separation anxiety problems), and externalizing problems (physical aggression and hyper-activity/inattention problems) (33). The survey consisted of 25-items rated on a 3-point Likert scale with response options, never or not true rated as 0, sometimes or some-what true rated as 1, often or very true rated as 2. Internalizing and externalizing problems are highly correlated and comorbid, with evidence suggesting these disorders area a part of a higher ordered general factor, termed p (35). To accommodate this finding, a new variable *general psychopathology* was generated by summating the 25 items, with a range of possible responses being 0-50. The larger value indicates greater symptoms of psychopathology in children.

Confounders

Variables included in statistical models to control for potential confounding at the individual level were, mothers' ethnicity measured at baseline, child's biological sex measured at birth, mother's educational attainment to date, self-reported before-tax household income at 3-years postpartum, and current marital status measured at 3-years postpartum.

To control for potential confounding at the neighbourhood-level variables included were, proportion recent immigrant (immigrated to Canada within the last 5 years) and proportion visible minority, which showed modest correlation (r = 0.69) however, were not collinear. As a measure of economic stress, proportion below the low-income cut-off (LICO) was included, which is a Statistics Canada-derived measure and quantifies the proportion of homes spending 20% more of income on necessities like food, clothing, or shelter than the average (36). The last variable included is the proportion of households making over $100,000 CAD after-tax. All neighbourhood-level variables were standardized using a Z-transformation.

Statistical analysis

Descriptive statistics for all variables were conducted to investigate data normality. Multicollinearity was assessed via pairwise correlations of neighbourhood variables. Next, a step-up regression approach was used by, first fitting a null model, and calculating the intraclass correlation coefficient (ICC). The ICC for the null model = 0.0144, p=0.03 (not shown) indicated a statistically significant difference in general psychopathology problems among children between neighbourhoods. To account for the nested data structure, mixed effects linear models with 2-levels was used to evaluate the hypothesis, whereby, children (level-1) were nested within neighbourhoods (level-2) (37). Second, a crude model with only income inequality was fit to the data to assess the bivariate relationship between income inequality

and general psychopathology. Third, individual-level confounders were added, followed by neighbourhood-level confounders. All statistical analyses were completed using STATA version 15.1® (38). To evaluate the relationships, a two-sided p-value of α≤0.05 was used.

Results

Demographics for the sample analyzed can be found in Table 1. The mean response for general psychopathology was 10.51 (SD = 5.76; min, max = 0-37). The sample also tended to contain more males (52.53%), mothers were more often partnered (95.11%), Caucasian (81.11%), who made more than $80,000 CAD before tax (78.73%), and most mothers have at least some post-secondary educations (81.99%). Descriptive statistics for the 184 neighbourhoods in Calgary can be found in Table 2. The mean Gini coefficient across the 184 neighbourhoods in Calgary was 0.33 (SD = 0.05; min, max = 0.20-0.56). Contextually, a Gini coefficient of this magnitude is higher than the provincial index for Alberta of 0.32 and the national average of 0.31 in the year 2006 (39). Additionally, the proportion below a low-income cut-off was 4% (SD = 0.04; range 0-0.53), and the proportion visible minority was 21% (SD = 0.14; range 0-0.82).

The results of the statistical analysis are shown in Table 3. In the crude analysis, the ICC = 1.50% between neighbourhoods. In the univariate models (model 1) income inequality and general psychopathology among children was not statistically significant (β = -0.59, 95%CI; -0.39, 0.27). In model 2, adding individual level confounders did not change the findings (β = -0.02, 95%CI: -0.35, 0.31). In the fully adjusted model neighbourhoods accounted for only 0.5% of the variance of general psychopathology problems among children. The effect size of neighbourhood income inequality on general psychopathology among children (model 3) accounting for neighbourhood confounders was not statistically significant (β = 0.07, 95%CI: -0.29, 0.45). Including area-level confounders in the model (model 3) changed the direction of the coefficient from negative to positive.

Discussion

To our knowledge, this study is the first to examine the association between neighbourhood income inequality and general psychopathology in children. Our results suggest that income inequality is not associated with general psychopathology problems at 3-years of age. However, there are a few speculative reasons why income inequality was not associated with psychopathology in children.

Table 1. Demographics of AOF sample at 3-years postpartum living in Calgary, Canada		
Variable	Mean (SD)	Min, Max
P factor score†	10.51(5.76)	0 to 37
	n	%
Sex		
Female	770	47.47
Male	852	52.53
Marital status		
Married/common-law	1574	95.11
Single/other	81	4.89
Mother's ethnicity		
Caucasian	1335	81.11
Non-Caucasian	311	18.89
Household income		
Less than $80,000 annually	352	21.27
Greater than $80,000 annually	1303	78.73
Maternal education††		
Some post-secondary or less	1357	81.99
Graduated post-secondary or more	289	18.01
†P-factor score is a continuous score of both of internalizing and externalizing psychopathology domains		
†† Some post-secondary high school or less, and graduated post-secondary or graduate degrees, denominators may not be equal.		

Table 2. Neighbourhood characteristics of sample (n = 184) in Calgary, Canada		
Variable	Mean (SD)	Min, Max
Gini coefficient	0.33(0.05)	0.20 to 0.56
Proportion visible minority	0.21(0.13)	0 to 0.82
Proportion recent immigrant	0.06(0.04)	0 to 0.27
Proportion below LICO	0.04(0.04)	0 to 0.53
Proportion Over $100,000 CAD	0.32(0.14)	0.3 to 0.76
LICO = Low-income cut-off.		

A possible reason for the lack of non-statistically significant findings in the current study, is the modifiable areal unit problem (MAUP). MAUP occurs from using arbitrarily defined administrative boundaries like census tracts used to differentiate areal units (40). For example, a study investigating social capital on crime victimization in Japan, observed two different results in the association between social capital and crime victimization when the method to define the neighbourhood boundary (Spatial Durbin model versus Census Tracts) changed (41).

Another reason is, neighbourhood residence is assumed to be invariant during the follow-up period, as postal codes were only collected at baseline. During the follow-up period if participants moved from a high-income inequality neighbourhood to a low-income inequality neighbourhood before 3-years postpartum, this could bias the findings toward the null.

Regardless of the mechanisms of action linking income inequality to maternal mental health (i.e., social capital, status competition), it is speculated income inequality may function through mediatory processes at the familial level which would directly influence children (9). One familial risk factor which could mediate this process, is maternal depressive symptoms. For example, state income inequality

Table 3. Mixed effects linear regression between general psychopathology among preschool aged children and income inequality across 184 neighbourhoods						
	Model 1 (n=1655)		Model 2 (n=1615)		Model 3 (n=1615)	
Fixed effects	β	95% CI	β	95% CI	β	95% CI
Income inequality	-0.59	-0.39, 0.27	-0.02	-0.35, 0.31	0.07	-0.29, 0.45
LICO					-0.20	-0.76, 0.37
Visible minority					0.44	-0.06, 0.95
Recent immigrant					-0.10	-0.60, 0.40
Greater than $100,000					-0.34	-0.78, 0.01
Household income						
≥$80,000			Ref	Ref	Ref	Ref
<$80,000			0.87	0.14, 1.61	0.72	-0.03, 1.47
Education						
Some post-secondary or more			Ref	Ref	Ref	Ref
High-school or less			0.13	-0.62, 0.89	0.07	-0.69, 0.82
Marital status						
Coupled			Ref	Ref	Ref	Ref
Single			0.96	-0.39, 2.31	0.93	-0.42, 2.28
Ethnicity						
Caucasian			Ref	Ref	Ref	Ref
Non-Caucasian			0.31	-0.41, 1.04	0.15	-0.59, 0.89
Sex						
Female			Ref	Ref	Ref	Ref
Male			0.69	0.13, 1.25	0.68	0.12, 1.24*
Random effects						
Area level	0.50	0.13, 1.87	0.33	0.06, 1.90	0.17	0.00, 4.41
Residual	32.66	30.45, 35.03	32.37	30.17, 34.75	32.41	30.20, 34. 79
ICC (area-level)	0.015		0.01		0.005	
ICC (individual-level)	0.985		0.99		0.995	
LICO = Low-income cut-off. ICC = intraclass correlation coefficient (37) *p<0.05,						

is associated with maternal depressive symptoms among women of low income (24). Another study observed higher state income inequality was associated with greater depressive symptoms among women (23). Subsequently, maternal depressive symptoms at differing stages of development are associated with greater internalizing and externalizing problems in children (25), and adolescents. For example, researchers observed mental health problems during pregnancy were associated with an increase in odds of externalizing problems in children at 5 years of age in Finland (42). In longitudinal studies, a sample of mother-child dyads living in 10 locations around the USA, found maternal depressive symptoms were associated with elevated internalizing symptoms in children from 1st to 3rd grade, and from 6th grade to age 15, and was also associated with increasing child externalizing problems from 36 to 54 months of age (43).

One possible reason for not observing a significant relationship between income inequality and psychopathology problems among preschool-aged children is using data from a single time point. A lag effect between exposure to income inequality and emotional and behavioural outcomes would require a longitudinal analysis of the data. One paper observed using US based national health interview survey

data that a lag period between income inequality exposure and mortality was 5 years (44). The strength of the income inequality and mortality relationship peaks around 7 years, before diminishing by 12 years post-exposure period (44). In the case of mental health, US researchers observed lower social capital at the county-level partially mediated the relationship between state-level income inequality and individual-level depressive symptoms among a sample of middle-aged adults two decades later (18). These results suggest a substantial lag period between income inequality exposure and mental health-related problems. The limitation in the current study was the inability to include data from subsequent waves of the AOF cohort, which may limit the detection of an association between income inequality and preschool children internalizing or externalizing problems. Future research should use longitudinal analysis to assess the relationship.

Limitations

Findings from this investigation should be interpreted with caution considering several limitations. First, cross-sectional data from AOF was used to assess our hypothesis, limiting the directional implications of the findings. Future research should analyze data collected longitudinally. Second, there is a lack of validity studies assessing the questionnaire used, except for the hyperactivity/inattention scale, which could lead to misclassification of children based on symptoms presentation that week. Third, child psychopathology may be differentially misclassified, as evidence suggests mothers presenting with depression are more likely to overrate their child's psychopathology symptoms in boys, compared to other informants like group care workers and teachers (45). Fourth, while the AOF cohort is, in general, representative of the parenting population, the sample tends to be more often partnered, and more educated than the parenting population in Calgary and the rest of Canada (26). In addition, due to missing data at the neighbourhood level, caution is warranted in extrapolating to other populations that may differ in their sociodemographic characteristics at the individual and neighbourhood level. Fifth, we were unable to observe a relationship between the environment and psychopathology problems among preschool aged children above and beyond the effects of genetic factors (46). To fully understand the relationship between income inequality and child's psychopathology, genetic factors should be included in analytic models. Sixth, there may be a lack of power to detect differences across neighbourhoods. Simulation studies suggest 30 groups with a minimum of 30 individuals within them if cross-level interactions and the estimation of accurate level-1 and level-2 random effects are of interest (47). Taking these limitations into consideration,

the results of the study can be generalized to parenting populations of Calgary along with other major metropolitan cities in Canada.

In conclusion, the findings from this study demonstrate that income inequality was not associated with preschooler's psychopathology at 3-years of age may be due to a lack of statistical power. Future studies examining this relationship in the Canadian context should examine other metropolitan cities and use more up-to-date census data for income inequality. To date two studies have looked at cross-country comparisons showing negative impacts of inequality (9, 11), however, longitudinal examination at the neighbourhood-level remains uninvestigated. Future studies should examine early life exposure to income inequality at the neighbourhood-level and employ latent growth curve modelling or cross-classified models to determine the contribution of early life income inequality with later life psychopathology. Finally, studies should consider longitudinal structural equation modelling, to test whether income inequality is associated with preschooler's health through intermediary variables like maternal depression or child maltreatment, which would serve to strengthen the claims that income inequality is worse for population health.

Acknowledgement

Conflicts of Interest

Roman Pabayo is a Tier II Canada Research Chair. The authors have no conflicts of interest to report.

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