Neighbourhood income inequality and preschooler's internalizing and externalizing problems

By

Gregory Farmer

A thesis submitted in partial fulfilment of the requirements for the degree of

Master of Science

in

Epidemiology

School of Public Health
University of Alberta

Abstract

Background Several studies have linked neighbourhood social and economic characteristics to preschool-aged children's emotional and behavioural problems. Although income inequality has been identified as a risk factor for mental health and behavioural outcomes among adolescents, no studies have been conducted on young children less than 10 years of age. The objective of the current study is to explore the association between neighbourhood-level income inequality and internalizing and externalizing problems among preschool-aged children.

Methods We analyzed cross-sectional data from the All Our Families (AOF) longitudinal cohort located in Calgary, Alberta at 3-years postpartum. The analytical sample consisted of 1598 mother-preschooler dyads nested within 184 neighbourhoods. Mothers completed the National Longitudinal Survey of Children and Youth adapted Child Behaviour Checklist (NLSCY-CBCL), which assessed internalizing and externalizing symptoms of their child. Multilevel logistic regression modelling was used to assess a relationship between neighbourhood income inequality measured via the Gini coefficient and preschooler's internalizing and externalizing problems.

Results The mean Gini coefficient across the 184 neighbourhoods was 0.33 (S.D = 0.05) and ranged from 0.23 to 0.55. Neighbourhood income inequality was not associated with either externalizing (OR = 1.04, 95%CI: 0.89, 1.20) or internalizing (OR = 0.96, 95%CI: 0.84, 1.14) problems in preschoolers. Before-tax household income was significant in internalizing (OR = 1.38, 95%CI: 1.02,1.86), however, was not significant for externalizing problems in fully adjusted models.

Conclusion Neighbourhood-level inequality is not associated with internalizing or externalizing problems at 3-years of age. No association was observed among preschool-aged children because

they may be too young to experience its effects or are more sensitive to the household

environment such as lower household incomes, as opposed to their neighbourhood environment.

Preface

This thesis is an original work by Gregory Farmer under the supervision of Dr. Roman Pabayo and thesis committee members Dr. Sheila McDonald, and Dr. Shelby Yamamoto. The idea for this research study came from Dr. R. Pabayo, as part of a grant provided through M.S.I. Foundation under grant no. 896 and is a part of a larger study under University of Alberta Ethics project ID: RES0040064RA (see appendix D).

G. Farmer made substantial contributions to the design, methodology, data cleaning, analysis, data interpretation, and writing of the manuscript. The contributions of Dr. R. Pabayo included acquiring data and funding, guide research design and methods, interpretations of the analysis, and multiple revisions of the manuscript. Committee members Dr. S. Yamamoto contributed to the design, methodology and critical review of the manuscript. Dr. S. McDonald contributed to the design, methodology, and critical review of the manuscript, along with analysis interpretation. Dr. Chris Wilkes contributed with a critical review of the manuscript.

This thesis has not been previously published, and the analysis section of this thesis will be adapted and submitted in collaboration with Dr. S. McDonald, Dr. S. Yamamoto, Dr. Chris Wilkes, and Dr. R. Pabayo.

Acknowledgements

Table of Contents

List of tables

List of figures

Glossary of terms

OR = Odds ratio
Gini = Gini coefficient
NLSCY = National Longitudinal Survey of Children and Youth
CBCL = Child Behaviour Checklist
AOF = All Our Families
SES = Socioeconomic Status
DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition
DSM-V = Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
CDF = Cumulative Distribution Function
SD = Standard Deviation
SDOH = Social Determinants of Health
LICO = Low income cut-off
SAGE = Secondary Analysis to Generate Evidence

1. Introduction

To assess preschool-aged children's emotional or behavioural problems, research uses two different tools; 1) clinical tools based on the Diagnostics and Statistics Manual of Mental Disorders (DSM),[1] or 2) checklists tools, such as the parent completed Child Behaviour Checklist (CBCL).[2] The CBCL usually dichotomizes emotional and behavioural problems into two spectrum measures referred to as internalizing and externalizing problems.[3] Externalizing spectrum disorders can include disorders such as physical aggression, hyperactivity/inattention, or conduct disorders, and are behaviours that are typically directed outward.[3] Internalizing problems is a spectrum of disorders that are typically directed inwards, and can include anxiety, depression, or separation anxiety disorders.[3] Across all ages, it has been argued that mood and anxiety disorders should be combined into "emotional distress".[4] In fact, some versions of the CBCL like the Canadian adapted version,[5] combine emotional and anxiety subscales to generate an emotional/anxiety subscale which comprised overanxious, obsessive-compulsive and affective disorders.[6] In this thesis emotional and behavioural problems are used interchangeably with internalizing and externalizing problems to refer to a class of disorders in children.

The epidemiology of preschool-aged children's (3-4 years of age) psychopathology in Canada is sparse. One study from the Ontario Child Health Study (OCHS), estimates the prevalence of emotional and behavioural problems amongst a sample of 4–11-year-old children to be 18-22%, depending on the respondent.[7] In other populations of preschool children, the prevalence of emotional and behavioural problems ranges from 0.3-23.7%[8-14] (see Appendix A for list of studies). Based on a review by Egger & Angold, the prevalence of emotional and behavioural problems in studies using parental completed symptom checklists in community-based samples is 7-25% in children aged 2-5 years of age.[15] In the same review, researchers

reporting mental disorders meeting clinical thresholds based on the diagnostic and statistical manual for mental disorders (DSM) criteria reported a prevalence of 16-26.4%.[15] Although high, these reported prevalence estimates typically drop once impairment is a stipulated criterion for disorder diagnosis.[15]

A clear indication of the trend of maladaptive problems in Canadian preschoolers is unknown. According to a systematic review in Australia and the Netherlands, trends in preschooler's anxiety/depression, hyperactivity/inattention, and behavioural problems were observed to be decreasing over two decades.[16] Mixed levels of evidence make it difficult to distinguish the true prevalence and trend of preschooler's emotional or behavioural problems in Canada. Although the prevalence and trend of emotional and behavioural problems are not well documented in Canada, these disorders in preschool ages can persist into later stages of development and into adolescence.[17] Persistence of emotional and behavioural problems in adolescences can have long term health and social consequences,[17-20] like juvenile delinquency. Understanding risk factors which contribute to these health and social sequela in preschool children is imperative.

One area of research focuses on the characteristics of the developing child's neighbourhood environment and seeks to understand how neighbourhood contextual factors play a role in determining emotional and behavioural development.[21] Children's outcomes based on the neighbourhood environment in which they live, emphasizes the Social Determinants of Health framework (SDOH), which stipulates, people's health is determined by the conditions in which people live, grow, work and age, including the distribution of money, power and resources,[22] including income inequality.

Income inequality, defined as the unequal distribution of income within a geographical area,[23] and has been observed to have implications for population health,[24-26] as well as the health of infants,[27] and children.[28,29] Income inequality may be detrimental to the health of children because income inequality may increase familial tensions and provoke a scared response in children resulting from increased familial conflict.[30] For example, income inequality has been observed on several accounts to be associated with the mental health of adults,[25,26] and mothers.[31] This is concerning because maternal depression is an associated risk factor for emotional and behavioural problems in young children.[32]

Investigating the association between income inequalities and preschooler's emotional and behavioural problems would provide preliminary evidence for interventional research. Identifying new risk factors which influence preschooler's psychopathology in Canada would allow for the development of targeted interventions. In a meta-analytic review of studies examining income inequality and depression in adults by Patel et al,[25] it was hypothesized interventions aimed at increasing resilience in children living in areas of high-income inequality could help mitigate the development of maladaptive behaviours in adolescence. A limitation to this study was the failure of the authors to specify which age would be the most effective to intervene on. In child studies, intervening during early preschool-aged years of life, would cost less, and provide greater benefits than waiting until adolescence or adulthood to intervene.[33]

Therefore, the study of income inequality and preschooler's emotional and behavioural problems in the Canadian population is needed. That is why the objectives for this thesis are to: 1) conduct a literature review and qualitative synthesis on studies examining income inequality and child and adolescent emotional or behavioural problems, which will serve to identify the gaps in the literature; and 2) explore neighbourhood-level income inequality and its association

with preschooler's internalizing and externalizing problems at 3-years of age, while controlling for socio-demographic, and neighbourhood confounders. The following question will be explored using 1598 mother-child dyads from All Our Families Cohort (AOF) study located in Calgary, Alberta.

2. Background

This chapter is a quick overview of risk factors for externalizing and internalizing problems among preschool-aged children at the individual, family/household, and neighbourhood levels. Next, income inequality is defined and its documented significance in Canada is presented. Finally, I describe how income inequality may be associated with children internalizing and externalizing problems through direct and indirect pathways using current evidence.

2.1 Determinants of preschooler's emotional and behavioural problems

The epidemiology of preschooler's emotional and behavioural problems has been observed to follow several different trajectories with several associated risk factors. According to the bioecological theory,[34] child development is determined by a complex interplay of determinants including biological determinants (e.g., sex of the child, and temperament); parent-child relationships (e.g., hostile ineffective parenting strategies, and maternal depression). Risk factors which affects a child and their immediate surroundings is known as proximal processes.[35] While distal processes are those a child may or may not be directly engaged in, but may still work to influence development.[35,36] Household environment (e.g., economic stress, and poverty), and neighbourhood/ communities (e.g., collective efficacy, and socio-economic disadvantage) are examples of distal processes which may alter emotional and behavioural development in preschoolers.

The following section provides a brief overview of risk factors that influence both proximal and distal processes which can either be protective or harmful in shaping the emotional and behavioural development in preschoolers. Emphasis is placed on neighbourhood social and economic factors as they are relevant risk factors to the current study.

2.1.1 Biological factors

Several risk factors are associated with sustained elevated trajectories of emotional and behavioural problem symptoms in preschoolers. Primary risk factors are the child's biological sex of male and child temperament. For example, Parkes et al,[37] observed having a difficult temperament was associated with high internalizing symptoms over time, compared to children experiencing moderate and low symptoms of internalizing problems. For behavioural problems, evidence shows mixed results. In a study by Tremblay et al,[38] male biological sex was not associated with high or moderate physical aggression symptoms over time. Alternatively, Côté et al, found male biological sex and difficult temperament were associated with elevated physical aggression symptoms over time.[10]

The evidence suggests that child factors such as the biological sex of the child, and child temperament are important predictors of internalizing and externalizing problems. These results are reported in a systematic review by Carneiro,[39] identifying several correlates and predictors of early childhood internalizing and externalizing problems. In particular child temperament and sex of the child were identified in several studies to be associated with externalizing problems, but not internalizing problems.[39] Therefore, boys are more susceptible than girls to externalizing problems, with mixed results of sex differences in internalizing problems. Child temperament is another important consideration in both externalizing and internalizing problems among preschool-aged children.

2.1.2 Family/household factors

Besides a child's biological determinants, several familial, and household factors have been observed to be associated with preschool-aged children's internalizing and externalizing problems. For instance, a recent systematic review reported several studies findings; maternal young age, low maternal and paternal education, maternal and paternal mental health, maternal depression and low socioeconomic status, as either being a correlate or predictor of internalizing or externalizing problems.[39]

Including the correlates and predictors above, poverty has been observed to be associated with greater child internalizing and externalizing problems,[40] and early childhood poverty predicts later childhood internalizing and externalizing problems.[41] Other factors such as household or family low income have been longitudinally observed to be associated with increased risk for externalizing and internalizing problems in preschoolers.[37,38,42]

Other economic measures like economic disadvantage during the prenatal period of life (measured as family income, financial difficulties, and adjustments the family had to make because of financial difficulties) was observed to be associated with increased internalizing and externalizing problems in preschoolers aged 3.[43] In the same study two noteworthy pathways were observed to be statistically significant at an alpha level 0.05. Firstly, economic disadvantage was observed to be associated with greater maternal depressive symptoms, which in turn was associated with harsh parenting which increased toddler internalizing and externalizing problems.[43] The second, economic disadvantage was observed to be associated with maternal depressive symptoms, which in turn was associated with greater parenting stress, which was associated with higher preschooler's internalizing and externalizing problems.[43] Subsequently, maternal depression and depressive symptoms have been observed to be

associated with a greater likelihood of preschooler's behavioural problems and worse socio-emotional development cross-sectionally,[44-47] and hyperactivity problems and internalizing problems over time.[37,48,49] High symptoms of maternal depression may increase the likelihood of using parenting styles such as hostile or ineffective parenting, having increased parenting hassles and higher household chaos, which can have adverse influence on preschooler's conduct and emotional problems over time.[50]

2.1.3 Neighbourhood factors

Neighbourhood determinants like neighbourhood socioeconomic status are associated with worse emotional and behavioural outcomes in young children.[21] Studies have shown consistently the amount of variation in the emotional or behavioural problems attributable to differences between neighbourhoods is 1.6%-11%.[51-53] Across other health outcomes in children and adolescents in a systematic review, results indicated 0.57-21% of the variance in the health outcomes could be attributed to differences between neighbourhoods, like neighbourhoods with higher versus lower socio-economic disadvantage.[54]

The determinants of neighbourhood characteristics on child health can be divided into two main categories, structural aspects (e.g., income, unemployment rates) usually defined by census data, and social organizational aspects (e.g., social cohesion),[21] which is characterized usually by aggregated individual measures of social processes of the neighbourhood like, perceived social connectedness or organizational participation.[21]

Structural factors

Neighbourhood structural characteristics such as socioeconomic deprivation (i.e., proportion single-parent families or proportion unemployed) were observed to be associated with increased problem behaviour in a sample of Dutch children aged 5-7 years old, after controlling

for individual SES.[55] Neighbourhood affluence (proportion of households making >$50,000) has also been observed to be associated with lower behavioural problems among a Canadian sample of 4-5-year old's in fully adjusted models.[56]

Social factors

Social processes of a neighbourhood may have a protective or adverse effect on emotional and behavioural problems in preschool children. One measure of social processes is social cohesion, defined as peoples willingness to cooperate with each other, across several collective enterprises in which society must do to survive and prosper.[57]

Measuring social cohesion at the individual level involves usually asking individuals about their social relations including individual perceptions (trustworthiness of neighbours) or behaviours (civic engagement).[58] To study neighbourhood social cohesion, researchers aggregate social cohesion measured at the individual level in order to compute the average score, for example, within the neighbourhood, state, or country, which allows for the study of social cohesion as an ecological construct.[58]

Neighbourhood social cohesion (i.e., perceived neighbourhood cohesion) has been observed to be associated with preschooler's emotional problems.[56] In another study using a sample of Canadian children followed over time from preschool into adolescence, it was observed that a decrease in neighbourhood social cohesion led to an increase in hyperactivity problems into adolescence.[59] That is, neighbourhoods with less social cohesion were observed to be associated with worse emotional and behavioural problems in preschoolers. Other researchers using data from Chicago USA, observed greater neighbourhood organizational participation aggregated to the census-tract level (as a proxy for neighbourhood social process), decreases the likelihood of exhibiting internalizing problems in children aged 5-11 years.[51] In contrast, one

study observed high levels of social cohesion to have a detrimental effect on internalizing and externalizing symptoms,[60] suggesting that high social cohesion may work to harm health by reinforcing unhealthy norms.[61]

The evidence provided above suggests that the characteristics of neighbourhood residents can influence children above the influence of biological, family, and household characteristics. However, a particular neighbourhood characteristic that may be worse for preschooler's emotional and behavioural problems is income inequality.

2.2 Income inequality

Income inequality is a term used to describe the unequal distribution of income in society or residential area, against a set standard of how income should be distributed.[62] To quantify income inequality in social epidemiologic research, the Gini coefficient is commonly used.[63] Further explanation is provided elsewhere.[62,63] Briefly, the Gini coefficient is based on the Lorenz curve, which plots the cumulative proportion of incomes in a defined geographical location, over the cumulative proportion of the population which produces the Lorenz curve (see figure 1).[23,63] To quantify how "unequal" the Lorenz curve is, a 45-degree line (line of perfect equality) is added to the graph and represents the ideal standard of how income should be distributed in society.[63] For example, in an ideal world, 50% of the population theoretically should earn 50% of the total income.[63] In figure 1, the letter A denotes the area under the line between the line of perfect equality and the Lorenz curve, while the area denoted B is the remainder.[63] To calculate the Gini coefficient, a ratio for the area between the Lorenz curve and the line of perfect equality is taken.[23]

The Gini coefficient is a unitless value that has limits between and including 0 and 1, whereby, the numeric value 1 indicates perfect inequality (where all the wealth is held by one

household/person in a defined geographical area) and, 0 indicates perfect equality (wealth is distributed evenly throughout the households for a defined geographical region).[62] The interpretation is; the greater the value of the Gini coefficient, the greater the income inequality there is, and the smaller the value of the Gini the greater the equality there is in the distribution of income.[23]

Figure 1 Gini coefficient calculation using theoretical data
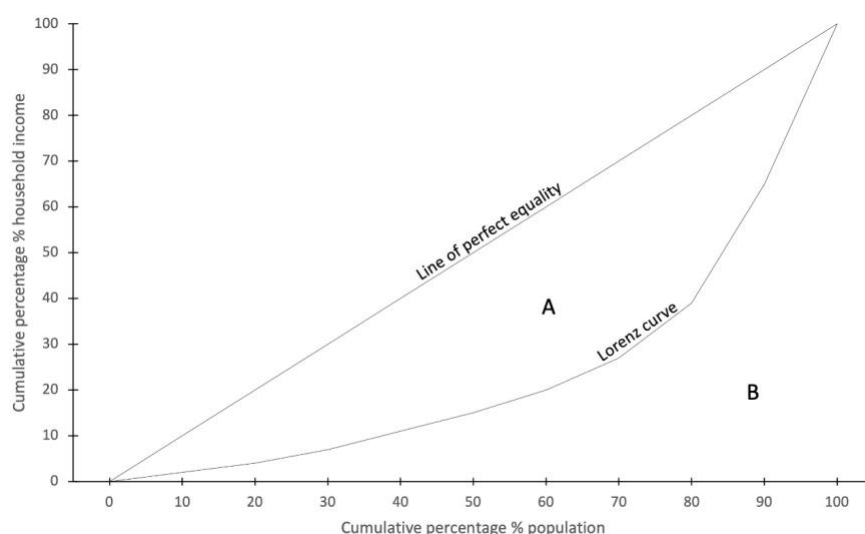
Note: Figure recreated from De Maio[63]

Gini calculation $= \dfrac{A}{A+B}$

2.2.1 Income inequality trends in Canada

In Canada, income inequality increased from the 1980s only to peak in the early 2000s, before declining. A study by Milligan,[64] used Canadian Census data of after-tax household income to assess the trend of income inequality between 1980 to 2005. The study revealed that the average level of income inequality in Canada has been rising steadily, with estimates increasing from 0.312 in 1980 to 0.349 in 2005.[64] According to Statistics Canada, the Gini coefficient has decreased from 0.317 to 0.299 between the period of 2005 to present year.[65]

Although income inequality has decreased since 2005, the effects of living through periods of income inequality may take decades to impact health.[66]

An analysis of cities across Canada reveals the city of Calgary and Toronto possess the highest overall average Gini coefficient amongst large metropolitan cities.[67] However, Calgary was the city with the largest variation in the Gini coefficient (i.e., the largest spread across the census tracts), with the Gini coefficient ranging from 0 to 0.64, with a mean Gini of 0.40 (see figure 2).[67] The city of Calgary has experienced the greatest change in income inequality between 1980-2005 compared to other major Canadian cities.[68]

The Gini coefficient for the City of Calgary estimated at 0.33, is above a threshold of 0.30, which according to a meta-regression analysis by Kondo et al,[66] is a suggested minimum Gini coefficient needed to influence health.[66] This proposed threshold, however, should be interpreted as a theorized and potential threshold, as the vast majority of studies are observational which limits the causal interpretation of the findings.[66] Regardless, the impact of income inequality in Canada is needed.

Figure 2 Income inequality across City of Calgary neighbourhoods (n = 206)

Neighbourhood Gini
- 0.00 - 0.14
- 0.14 - 0.27
- 0.27 - 0.41
- 0.41 - 0.55
- 0.55 - 0.68
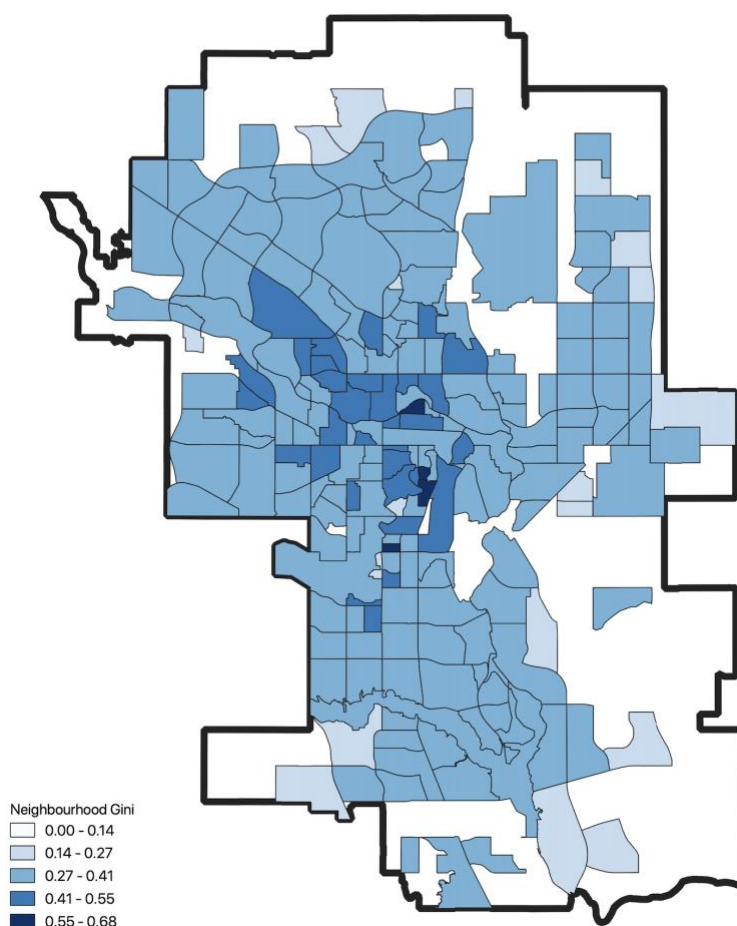
2.3 Linking income inequality to preschoolers

Income inequality is associated with a wide range of health outcomes in infants, children, and adults.[24-27,29] Theories linking both income inequality (an ecological variable), and health (an individual-level variable) are based on empirical evidence with limited studies testing mediation. Regardless, there are three postulated pathways: social comparisons,[69] social capital/ cohesion,[70]

and the neo-materialist view.[71] All three pathways have been theorized which may work alone, in some combination, or not at all, with no model being the most definitive.[61]

In this section, theoretical justification linking income inequality to preschooler's outcomes is explored. A visual of the mediators and their proposed relationship with preschooler's internalizing and externalizing problems is provided in figure 3, but does not represent a causal relationship.

2.3.1 Income inequality and social comparisons

The first pathway linking income inequality to worse health is through unpleasant social comparisons.[70] More detail is provided elsewhere.[69,72,73] Briefly, individual's discernment of their status rank in society can have a stress response, predicated on their relative deprivation to others close in rank to them.[61] Authors, Pickett & Wilkinson,[73] using animal studies,[74] argue that challenges to dominance hierarchies are rarely done by members far apart on the hierarchy, rather when they are very close. That is, you compare yourself to someone with a similar income, job, or age. For example, Kawachi & Subramanian,[61] argue using empirical sociological research that, in highly income unequal areas, an individual may not be absolutely deprived of material goods (i.e., able to afford food, water, clothes), but may be relatively deprived of the right kind of goods (i.e., the latest iPhone) or may have a false belief they should feasibly own goods other people have when they cannot afford them.[61] These types of confrontations, can result in feelings of frustration, and stress,[61] and thoughts of being left behind,[72] which may influence health, including depression. Evidence testing this relationship across 30 wealthy countries, found higher income inequality and overall well-being in adults was partially mediated by status anxiety.[75] In figure 3 an arrow starting at income inequality and ending at stressful social comparisons depicts this relationship.

2.3.2 Income inequality and social cohesion

Theorists such as Kawachi & Subramanian,[61] extend the idea that income inequality creates a "pollution effect" which directly influences the health of everyone in society regardless of age, ethnicity/race, income level or educational attainment. This pollution effect may cause weaker social bonds and less social cohesion.[61,76] According to a review of the literature, areas with higher income inequality have greater mistrust, reduced social participation and social group membership.[72] A lack of societal or community social cohesion may generate social isolation, alienation and loneliness leading to depression.[25,76] In fact, one study from the US, observed lower social capital (measured as the total density of non-profit, social, civic, and religious organizations in a county, percentage of the population that voted in presidential elections, and response rate to the decennial census) 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 2 decades later.[77] In figure 3, this relationship is depicted with an arrow starting at income inequality and ending at eroding social cohesion/ capital.

2.3.3 The neo-materialist pathway

The last theory is the neo-materialist view of income inequality.[71,78,79] In this view, income inequality is only one of many neo-material processes which function to make the health of society worse.[71] Other concurrent processes include the loss of material resources, shifts in political agendas causing cuts to social spending and education, and loss of health and social infrastructure causes ill-health.[71] For example, empirical research by Kaplan et al,[79] determined USA states with high-income inequality spent less on education and had a higher percentage high school dropouts, lower reading proficiency, and fewer library books per capita. Support for the neo-material view is limited,[75] and some believe that the neo-material pathway is more

relevant for larger geographical analysis like countries, in favour of the social capital and social comparison hypothesis when investigating neighbourhoods.[25,80] The neo-materialist pathway is not depicted in <u>figure 3</u>.

2.3.4 Income inequality and preschooler's outcomes

As mentioned, studies linking mediators to preschooler's emotional and behavioural problems are sparse. However, some studies have begun to hypothesize a link. One study by Elgar et al,[81] postulated that early life income inequality may generate greater early life adversity (i.e., maternal depression, child maltreatment) which alters developmental trajectories. Using panel data from 40 countries, the study observed exposure to income inequality between 0-4 years of age was associated with an increase in dual involvement in bullying perpetration and victimization in adolescence, when controlling for lifetime inequality and other confounders.[81] Another study by Elgar et al,[82] using panel data from 40 countries, showed children aged 4-5 years exposed to income inequality experienced worse-off well-being later into adolescence, controlling for life time inequality and confounding variables. Based on the above evidence, it is plausible that income inequality works as a catalyst to determine a child's developmental trajectory.

A probable catalyst between income inequality and preschooler's internalizing and externalizing problems is through maternal depressive symptoms. Several studies have investigated the direct effects of income inequality at varying geographical units and depressive symptoms in adults. For instance, a meta-analysis study by Patel et al,[25] reported a Mantel Haenszel pooled risk ratio of 1.19 (95% CI: 1.07-1.31) based on studies investigating income inequality and depression. This is interpreted as a 19% higher risk of depression for those in high-income inequality areas, opposed to those living in low-income inequality areas. In another

meta-analytic review of income inequality and mental health-related illness, Ribeiro et al,[26] observed a pooled Cohen's d effective size estimate for mental health problems to be 0.06 (95% CI: 0.1 to 0.10), and 0.12 (95% CI: 0.05 to 0.20) for depression. Although the effect sizes of the above reviews were small, along with high heterogeneity in the geographical unit used in the analysis, the results suggest a relationship between income inequality and mental health and depression among adults.

In mothers with young children, high state-level income inequality is associated with greater symptoms of maternal depression, particularly, among women with low incomes.[31] That is to say, those with low incomes and who live in areas of great income inequality were more likely to report depression. Comparatively, another US-based study, Pabayo et al,[83] observed state-level income inequality was associated with depression among women, controlling for state and individual-level confounders. These results suggest that income inequality may increase the symptoms of depressive symptoms among mothers living in poverty, and women in general.

A probable link between income inequality and mental health problems among adult women and mothers is concerning because greater maternal depressive symptoms can increase preschooler's internalizing and externalizing problems,[32] and may produce greater child psychological maltreatment in preschoolers aged 3.[84] One study investigating children in the USA, observed higher state-level income inequality was associated with greater child maltreatment, compared to states with lower income inequality.[28] Although mediation was not tested in this study explaining how income inequality worked from an aggregate exposure at the state level to child outcomes, the ecological associational relationship observed may suggest that higher state-level income inequality alters household social processes, trickling down to afflict children's behavioural and emotional problems. In figure 3, this relationship is denoted with the

arrow starting at maternal depressive symptoms and going to preschooler's internalizing and externalizing problems.

Figure 3 Theoretical and tested pathways between neighbourhood income inequality and emotional and behavioural problems in preschoolers
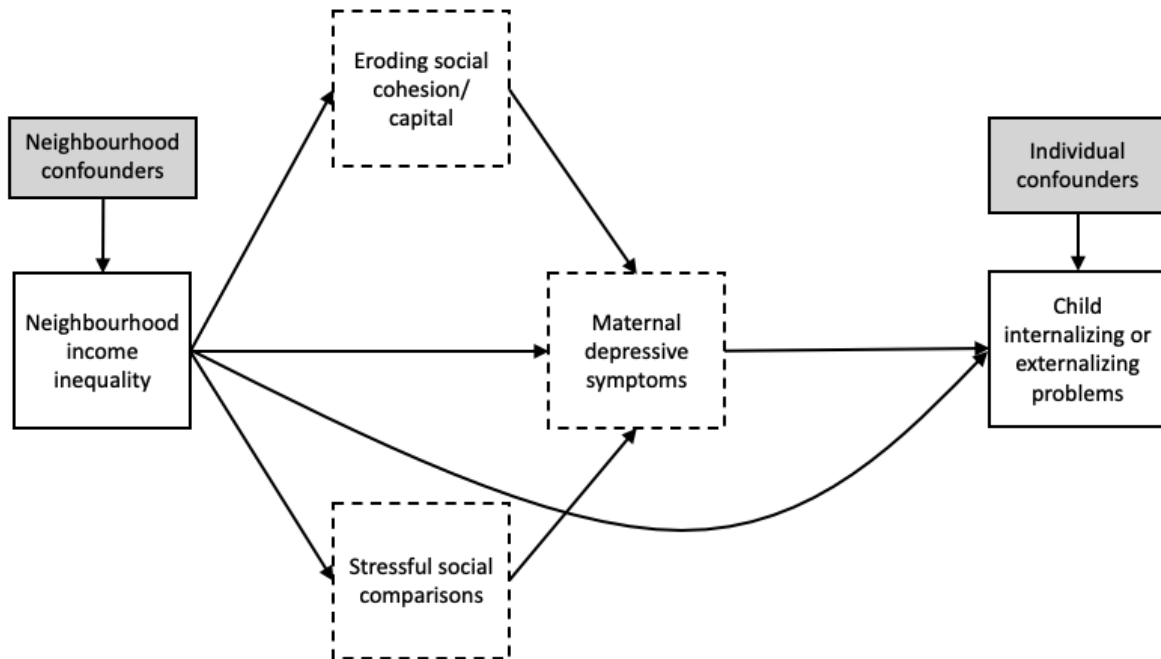
Note: Dashed boxes represent theoretical pathways, and solid lines are tested pathways in the current study.

This relationship does not represent a causal relationship, but a proposed relationship based on current knowledge on income inequality and health.

3. Literature review

The following section is a literature synopsis of income inequality and child or adolescent emotional and behavioural problems. A literature overview was conducted on studies investigating the effect of income inequality on emotional and behavioural outcomes which relate to mental health (i.e., depression/ depressive symptoms; emotional distress; anxiety) and maladaptive behaviours (i.e., physical aggression; hyperactivity or inattention; conduct disorder; oppositional defiant disorder). To include studies investigating contextual determinants of health

(neighbourhood environment or country socioeconomic conditions), area-level units were aimed to include school, neighbourhood, county, state/province. The aim of the literature search focused on children as opposed to adults, however, adolescents were not excluded, as the evidence on income inequality and child mental and behavioural well-being proved to be scarce.

3.1 Methods

The literature overview was conducted using 4 databases PsycINFO, Web of Science, PubMed, and Medline: via Embase and Ovid Medline(R) Peer-review articles from 1946 to May 15, 2020, were included. Database searching concluded on August 10th, 2021, for both outcomes of interest. Search strategies, databases, search terms, and inclusion criteria used to collect relevant studies can be found in Appendix B. The aim of this search was to investigate whether income inequality and young children's emotional and behavioural problems have been previously investigated in Canada.

3.2 Income inequality and emotional problems

A synopsis of the relevant studies is reported in table 1. The table gives author, sample, location, age of the sample, area unit of investigation, study design, outcome measure and the tool, covariates, income inequality measure and range, key findings of the study, and whether there was evidence of interaction or mediation or if interaction or mediation was tested.

3.2.1 Study characteristics

In total, thirteen studies were identified which examined income inequality and mental health problems in children and adolescents. Across the 13 studies, location of the studies were: USA (n = 4),[85-88] Iceland (n = 3),[89-91] Canada (n = 2),[92,93] Sweden (n = 1),[94] one using 50 USA states and District of Columbia,[29] one using 34 countries,[95] and one using 17 countries.[96] The ages of the participants across the studies were heterogeneous, with participants ages ranging

from 10-19 years, with no younger populations identified in the literature. Majority of the study designs were: cross-sectional (n = 7),[85-88,91-93] with the remainder using repeated cross-sectional (n = 3),[89,90,94] time series (n = 2)[95,96] and ecological (n = 1) designs.[29] The area unit used to calculate income inequality varied greatly across the studies. The most used area unit is school districts (n = 5),[87,89-91,93] country (n = 2),[95,96] and neighbourhoods/census tracts (n = 3),[85,86,88] USA states (n =1),[29] and provinces (n = 1),[92] and municipalities (n = 1).[94]

Most studies in the review used the Gini coefficient (n = 8)[29,85,86,89,92,94-96] to calculate income inequality. Two studies used the P80/20 ratio,[88,91] which takes the ratio of the top 20% to the bottom 20% of household incomes.[63] The interpretation of the P80/P20 decile ratio is similar to the Gini coefficient with a greater ratio measure indicating greater income inequality.[63] One of the three studies took the inverse of the P80/20 to generate the P20/80 ratio using tax returns including capital gains and also generated an index of equality that captured the change of income inequality over time across 10 years and 5-time points.[90] One study used below 50th percentile share which takes the total income held by the lower half of the population, and uses the less-well-off 50% as a reference group.[87] The final method used by one study,[93] is the squared coefficient of variation, which assesses the variation in household income within each area unit.[63] Although there is heterogeneity across the studies in methods used to calculate income inequality, the use of different methods yields similar results.[62]

To assess the relationship between contextual income inequality and health outcomes, social epidemiologists argue that multilevel models are necessary.[23] This is because multilevel models control for both individual-level and area-level variables simultaneously by controlling for within-cluster variation and between cluster variation allowing for the assessment of the

contextual effects of income inequality.[23] All studies except two used multilevel regression models.[29,86]

A key consideration for comparability of results across studies, is the health outcome measured. The most common assessment is checklists to measure symptoms of different domains of affective disorders. Checklists included; the multidimensional Hopkins symptoms checklist-90 (n = 3),[89-91] Modified Depression Scale (n = 1),[85] Psychometric Problems Scale (n = 1),[94] Center for Epidemiologic Studies-Depression Scale (CES-D) (n = 1),[87] Behaviour checklist (n = 1),[92] HBSC symptom checklist (n = 2),[95,96] Kessler K6 psychological distress scale (n = 1),[88] remaining studies used undefined checklists (n = 2),[93] Only one study used a clinical-based interview tool (composite international diagnostic interview using DSM-IV criteria), which diagnosed adolescents with clinical mental disorders.[86]

Outcomes across the 13 studies included, depressive symptoms (n = 2),[85,87] depression and anxiety symptoms (n = 3),[89,90,93] mental health problems (n = 2),[29,94] emotional distress (n = 1),[91] emotional problems (n = 1).[92] Three studies examined psychological problems/symptoms/distress (n = 3). One of the three studies,[95] generated an absolute and relative index of inequality in psychological symptoms. Absolute inequality took the absolute difference in psychological symptoms between the high and low socioeconomic status (SES) groups, while relative inequality in psychological symptoms is the percentage in health outcomes in the population that differ between high and low SES groups.[95] Only one study used a clinical diagnostic criterion (DSM-IV) which measured two class of disorders including mood and anxiety disorders.[86]

3.2.2 Supportive studies

Eleven studies in the review supported the contextual income inequality hypothesis that greater disparities between the rich and poor led to greater symptoms of emotional problems, compared to individuals living in areas with less income inequality. Beginning with country-level income inequality studies, Elgar et al,[95] observed across 34 countries, higher income inequality was significantly associated with greater psychological symptoms indicating worse mental health problems. Similarly, in 17 countries, Dierckens et al,[96] observed country-level income inequality was associated with higher average psychological symptoms. In the same study, it was observed that country-level income inequality was also associated with higher psychological symptoms between the higher and lower SES groups. In a study using data on the Swedish population, Kim et al,[94] found that country-level income inequality did not affect adolescent mental health, nor for either males or females. However, cross-level interactions were significant for all models between income inequality and economic disadvantage. The results at the ecological level indicate income inequality is worse for emotional health and is worse for individuals who are lower on the socioeconomic scale.

At smaller areas unit of observation such as the state level, Pickett et al,[29] observed that USA state income inequality was correlated with mental health problems in children aged 0-17 years. In a sample of adolescents attending school, Goodman et al,[87] observed higher school level income inequality was associated with adolescent depressive symptoms. In the same study when the analysis was conducted using multilevel models and individual outcomes, income inequality was significant accounting only for school characteristics. Once school aggregated income and individual demographics were accounted for, income inequality was insignificant.

This may point towards, the effect of individual demographic factors being stronger predictor of adolescent mental disorders, rather than contextual income inequality.[97]

Across the remaining studies which used smaller units of observation such as neighbourhoods and school districts, 8 studies observed significant effects of contextual income inequality. Among Boston adolescents Pabayo et al,[85] observed that after adjusting for neighbourhood and individual confounders, greater income inequality led to greater depressive symptoms only among girls. In another USA-based study, Rivenbark et al,[88] observed that census-tract income inequality was associated with psychological distress in univariate models. However, after controlling for census tract and demographic variables, there was no relationship observed between income inequality and psychological distress. In a Canadian study, Quon et al,[93] observed income inequality at the school district-level to significantly impact depression and anxiety symptoms, however, the relationship was not significant in the fully adjusted models. In a separate study by Valhjalmsdottir et al,[89] income inequality measured at the school district level yielded a significant effect on anxiety in 2006 as income inequality was high (higher anxiety symptoms), but when income inequality decreased by 2014, the relationship diminished. The authors credited this observation to the periodic effects of income inequality. The same study observed that in 2014 income inequality was associated with fewer symptoms of depression.[89]

Two studies attempted to test social capital/cohesion as a mediator in the contextual income inequality and emotional health relationship. Both studies did not find an association of mediation. In a sample of Boston youth, Pabayo et al,[85] did not find evidence that individual social cohesion mediated the inequality and depressive relationship. Interestingly, Valhjalmsdottir et al,[91] observed that after adding individual social capital to the model,

collective efficacy, social trust and sense of security, the effect of neighbourhood income inequality was significantly associated with greater symptoms of emotional distress, adjusting for demographics, neighbourhood social and economic characteristics. The authors of the study interpreted this effect as individual social capital playing a role in mitigating the effects on income equality as a moderator, but not as a mediator.

In total, only 1 of the 6 studies considered the time lag effects of income inequality. Valhjalmsdottir et al,[90] examined the effect of income inequality measured 1 year prior to the assessment of outcome in Iceland. In fully adjusted models, income inequality at the community level was not significantly associated with anxiety or depression. However, a change in income inequality over the study period was significantly associated with anxiety, but not depression. The authors interpreted this finding to reflect the lag effects necessary for income inequality to differentially affect anxiety and depression. The authors suggest income inequality may affect anxiety in a shorter lag time than depression.[90] Lag time has been suggested previously to be necessary for the effects of income inequality.[24]

3.2.3 Unsupportive studies

The remaining 2 studies were not in support of the contextual income inequality hypothesis. Authors, Quon et al,[92] did not observe an association between provincial-level income inequality and individual emotional problems accounting for age, sex, parental education, household income, and mean income. The insignificant findings were cited by the authors to be a result of homogenous income inequality across provinces. Similar findings were observed by McLaughlin et al,[86] who did not observe a significant association between census tract income inequality and a select group of DSM-V disorders. The authors argue that these insignificant findings are a result of small area units used in the calculation of income equality.

However, a repeat analysis using state-level rather than census tract income yielded similar insignificant effects of income inequality on adolescent mental disorders.

The findings above are not without their respective limitations. The most common being discussed in the literature is reverse causality. Of the 9 cross-sectional studies, 7 specifically mentioned reverse causality as a limitation to the findings.[85,86,89,91-93] Goodman et al, suggested school-district level income inequality may not capture the true income inequality of the area as children may be enrolled outside of the school district leading to lower income inequality estimates.[87] Additionally, the two ecological studies along with findings from Goodman et al,[87] are subject to the principle of the ecological fallacy as a limitation to the design. That is, the characteristics found at the group level, cannot be attributed to the individual level. While ecological studies and cross-sectional studies are important for developing hypotheses, and understanding the public health burden, the need for longitudinal follow-up is merited to establish a temporal relationship.

Residual confounding is another limitation, in the literature, three studies specifically discussed this limitation citing the failure to include certain key variables in their analyses. [85,87,94] The failure to include household income as an individual level independent variable, perhaps resulting in residual confounding effects.[57][58] The inability to include household income in the analysis when studying adolescent samples could be a result of the difficulty in measuring adolescent reported household income. Adolescent-reported household income may be misclassified compared to parental reports.[98] One study, determined that agreement between parents and adolescents in reporting household income is fair (k = 0.44) in a sample of adolescents with a mean age of 13 years.[98] However, after stratifying the groups by household stress (surplus, balance, and shortage in household income), the kappa agreement by the group

was: surplus = 0.43, balance = 0.34 and shortage = 0.31. This indicates that households with greater financial strain may be more challenging to ascertain accurate household income estimates for adolescents.[98]

In summary, income inequality is associated with symptoms of emotional problems among adolescents. Social capital/cohesion at the individual level has insignificant findings, however, these findings may be the result of confounding,[85] and further investigation may be warranted. Other findings indicate that individual social capital masks the effect of income inequality on adolescent emotional distress. Additionally, income inequality is a time-dependant construct and anxiety may be more immediately susceptible in adolescents, compared to depression.[90] No studies including Canadian-based studies in this descriptive analysis evaluated contextual income inequality and preschooler's emotional problems. With established effects in adolescents, investigations examining the conditions which give rise to these problems are merited. Investigations could include cross-sectional studies assessing an associational relationship, or if possible, conduct longitudinal investigations into emotional problems in adolescents beginning in preschool ages to better understand early life adversity leading to later life maladjustment.

Table 1 Literature examining income inequality and emotional problems amongst children and adolescents (n = 13)

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Valhjalm sdottir et al 2016[91]	Iceland N = 5,958 adolescents **Age:** 15-16	N = 102 school communities Cross-sectional	Multilevel models (2-level)	Emotional distress Multidimensional Hopkins Symptom checklist-90	**Area-level:** Residential mobility, proportion disrupted families, immigrant concentration, log median income, and distant from capital (Reykjavik) **Individual-level:** Gender, economic deprivation, moved, family disruption, immigrant, parental support, parental conflict, parental social networks, neighbourhood reciprocity, collective efficacy, neighbourhood contentment, sense of security, social trust	**Decile ratio:** P80/P20 **Range:** 4.47-39.90	ICC† = 2% in the null model for school communities Income inequality was not significantly associated with emotional distress in fully adjusted models β = 0.0025 (S.E. = 0.0017, p > 0.05). In fully adjusted models, individual social capital was added, and income inequality was significantly associated with adolescent emotional distress β = 0.0034 (S.E. = 0.0015, p≤0.01)	**Interaction:** No interaction tested **Mediation:** No mediation tested

Table 1 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Valhjalmsdottir et al 2018[89]	Iceland N = 10,223 adolescents (n = 5,469 from year 2006 & n = 4,754 from year 2014) Age: 15-16	N = 82 school communities Series/ pooled cross-sectional	Multilevel models (3-level)	Depression and anxiety symptoms Multidimensional Hopkins Symptom checklist-90	**Area-level:** Concentrated disadvantage index, mobility rate, capital area location, time point. **Individual-level:** Household deprivation, gender, age, family disruption, immigrant status	Gini Coefficient **Range:** 2006: 0.15-0.71 2014: 0.15-0.35	ICC† for depression 2006 = 1.6% in the null model for school community ICC† for depression 2014 = 1.9% in the null model school community ICC† for anxiety 2006 = 0.5% in the null model school community ICC† for anxiety 2014 = 1.6% in the null model school community **Time stratified analysis:** In 2006 there was a significant association between income inequality and anxiety β = 0.337 (S.E. = 0.147, p≤0.05). In 2014 there was a significant association between income inequality and depression β = -0.958 (S.E. = 0.434, p≤0.05).	**Interaction:** **Pooled analysis:** Income inequality* time interaction was significantly negative associated with depressive symptoms β = -0.874 (S.E. = 0.388, p≤0.05). **Time stratified analysis:** Household deprivation*income inequality interaction term was significantly associated with both anxiety β = 0.270 (S.E. = 0.125, p≤0.05) and depression β = 0.309 (S.E. = 0.132, p≤0.05) in the year 2006. **Mediation:** None tested

27

Table 1 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Valhjalmsdottir et al 2019[90]	Iceland N = 24,107 adolescents Age: 15-16	N = 76 neighbourhood communities Pooled series cross-sectional	Multilevel models (3-levels)	Depression and anxiety Multidimensional Hopkins Symptom checklist-90	**Area-level (level 3):** Capital location, concentrated disadvantage index (CDI), mobility rate, **Year (level 2):** Δmobility rate, ΔCDI, Δ(20/80) ratio, survey cycle, survey cycle^2 **Individual-level (level 1):** Gender, age, family deprivation, family disruption, immigrant status	**Decile ratio:** P80/P20 ratio = equality index **Range (year):** 2006 = 0.22 2009 = 0.22 2012 = 0.28 2014 = 0.28 2016 – 0.27	**Intraclass correlation:** **Anxiety:** ICC† for anxiety (level 3) = 2.1% in the null model for neighbourhood community ICC† for anxiety (level 3) = 1.3% in the fully adjusted model for neighbourhood community **Depression** ICC† for depression (level 3) = 2.2% in the null model for neighbourhood community ICC† for depression (level 3) = 1.4% in the fully adjusted model for neighbourhood community Income inequality (level 3) was not associated with either anxiety β = - 0.001 (S.E. = 0.073), or depression β = 0.075 (S.E. = 0.070).	**Interaction:** In partially adjusted models, Δ in equality index (P80/P20 ratio) over time was significantly associated with anxiety β = -0.580 (S.E. = 0.122, p≤0.001). In fully adjusted models, including survey cycle and survey cycle^2, Δ in equality index (P80/P20 ratio) over time was significantly associated with anxiety β = -0.367 (S.E. = 0.127, p≤0.05).

28

Table 1 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Pabayo et al 2016[85]	Boston, USA N = 1,878 adolescents Age: 13-19	Census tracts Cross-sectional	Multilevel linear models	Depressive symptoms Modified depression scale (MDS)	**Area-level:** Economic deprivation, neighbourhood danger, neighbourhood disorder, social cohesion, proportion black **Individual-level:** Age, US born, race, social cohesion, sex	Gini coefficient **Range:** 0.33–0.65	ICC† = 5% in the null model for census tract In fully adjusted models, income inequality was not significantly associated with depression scores β = -0.03 (95% CI –0.11 to 0.05).	**Interaction:** The Sex*Gini coefficient interaction was significant in fully adjusted models β = 0.11 (95% CI: 0.02-0.20).
Quon et al 2014[92]	Canada N = 11,899 adolescents Age: 12-17	Provinces Cross-sectional	Multilevel linear models (2 levels)	Emotional problems Behaviour checklist	**Area-level (province year):** Mean income after tax **Individual-level:** Household income, parental education, sex, age	Gini coefficient **Range (across Provinces):** 2000 = 0.285-0.325 2006 = 0.265-0.323	Province level income inequality was not associated with emotional problems β = 0.028 (95%CI: -0.02 to 0.07, p>0.05)	**Interaction:** Income inequality*household income β = 0.004 (95%CI: 0.02 to 0.02) **Mediation:** No mediation tested
McLaughlin et al 2012[86]	USA N = 6,483 adolescents Age: 13-17	Census tract Cross-sectional	Logistic regression	**Two classes:** 1) mood disorders, 2) anxiety disorders. Composite International Diagnostic Interview using criteria of Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV).	**Area-level:** Relative deprivation. **Individual-level:** Parental educational attainment, household income, subjective social status, age, gender, race/ethnicity.	Gini coefficient **Range:** Not specified	In fully adjusted multivariate models, census tract level income inequality was not associated with an indication of 12-month DSM-IV disorder in adolescents OR = 1.0 (95%CI: 0.9 to 1.0, p>0.05) In fully adjusted multivariate models, census tract level income inequality was not associated with adolescents' mood disorders OR= 1.0 (95%CI: 0.9 to 1.1), and anxiety disorders OR = 1.0 (95%CI: 0.9 to 1.1).	**Interaction:** No interaction tested **Mediation:** No mediation tested

Table 1 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Kim et al 2018[94]	Sweden N = 14,266 adolescents Age: 15-16	N = 14 municipalities Series cross-sectional	Multilevel models (2 levels)	Mental health problems Psychometric problems scale (PSP)	**Second level (survey year):** Economic disadvantage. country gross domestic product (GDP). **Individual-level:** Gender	Gini coefficient **Range:** Not specified	Country level income inequality was not significantly associated with adolescent mental health problems in either boys or girls.	**Interaction:** In fully adjusted models, restricted to only girls, country level income inequality was associated with greater psychosomatic symptoms when participants could not afford going to a concert $\beta = 8.34$ (S.E. = 1.58, $p<0.001$), going to a movie $\beta = 4.80$ (S.E. = 1.57, $p<0.01$), and visiting a dance club $\beta = 5.21$ (S.E. = 1.81, $p<0.01$) several times in the past month. In fully adjusted models, restricted to only boys, country level income inequality was associated with greater psychosomatic symptoms when participants couldn't afford going to a sports event several times in the past month $\beta = 7.28$ (S.E. = 2.18, $p<0.001$). **Mediation:** N/A

Table 1 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Goodman et al 2003[87]	USA N= 13,235 adolescents Age: 11-21	N = 132 schools Cross-sectional	Linear regression & multilevel linear regression (2 levels)	Depressive symptoms Center for Epidemiologic Studies-Depression Scale (CES-D)	**Area-level:** School size, school type, urbanicity, region of the country, percentage of non-white students in school, average school income. **Individual-level:** Sex, race/ethnicity, age, household size, family structure, parental education, generation in USA.	**Decile ratio:** Below 50th percentile share **Range:** Not specified	**Intraclass correlation:** ICC† = 2.8% (p<0.001) for school-level variance in depressive symptoms (from null model) **Ecological:** Income inequality at the school level had a significant effect on school aggregated depressive symptoms β = -0.14 (S.E.= 0.02, p<0.001). **Multilevel:** Income inequality was significant in the unadjusted model β = -0.12 (S.E.= 0.03, p<0.001). In fully adjusted model income inequality at the school level did not influence adolescent depressive symptoms β = -0.04, (S.E.= 0.03, p>0.05).	**Interaction:** N/A **Mediation:** N/A

Table 1 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Elgar et al 2015[95]	34 Countries Age: 11, 13, 15	N = 102 country/year groups Pooled time series	Prais-Winsten time-series regression models Multilevel linear regression (3 levels)	1)Average psychological symptoms (i.e., feeling low, nervous or difficulty sleeping) 2)Absolute inequality in psychological symptoms high and low socioeconomic status (SES) groups 3) Relative inequality in psychological symptoms across high and low SES groups Symptom checklist	None	Gini coefficient **Mean (SD) by year:** 2002 = 0.30 (0.05) 2006 = 0.30 (0.05) 2010 = 0.31 (0.05)	**Multilevel analysis:** ICC† for psychological problems = 4% **Pooled ecological time series:** Country level income inequality was significantly associated with greater average psychological symptoms β = 0.18 (95%CI: 0.15 to 0.21, p<0.0001). Country level income inequality was significantly associated with greater absolute inequalities β = 0.13 (95%CI: 0.03 to 0.22, p=0.0080) and relative inequalities β = 0.61 (95%CI: 0.15 to 1.06, p=0.0090) in psychological problems.	**Interaction:** N/A **Mediation:** N/A

Table 1 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Quon et al 2015[93]	Quebec, Canada N = 2,199 adolescents Age: 13-16	N = 49 School districts Cross-sectional	Multilevel linear regression (2 levels)	Anxiety, depression, self-esteem Not specified	**Area-level:** School education/employment index (SES at school level), school poverty rate, school district income (median household income). **Individual-level:** Age, sex, subjective socioeconomic status (SES), household income, parent education, district income.	Coefficient of variation **Range:** Not specified	In univariate models, an increase in income inequality was not associated with depression $\beta = -0.01$, or anxiety $\beta = -0.01$. In fully adjusted models, there was no association between income inequality and either anxiety $\beta = -0.01$, or depression $\beta = 0.01$. However, there was a significant association between income inequality and self-esteem $\beta = -0.04$ ($p<0.01$)	**Interaction:** N/A **Mediation:** N/A
Pickett & Wilkinson 2007[29]	USA N = 51, 50 USA states and District of Columbia Age: 0-17	USA states Ecological	Pearson correlation	Mental health problems (i.e., moderate, or severe difficulties in the area of emotions) Not specified	None	Gini coefficient **Range:** Not specified	State level income inequality was significantly correlated with mental health problems among youth $r = 0.37$ ($p=0.01$).	**Interaction:** N/A **Mediation:** N/A

Table 1 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Rivenbark et al 2019[88]	North Carolina, USA N = 1,927 adolescents Age: 10-16	Census tract Cross-sectional	Multiple linear regression	Psychological distress Kessler K6 Psychological Distress scale	**Area-level:** Median neighbourhood income, family economic disadvantage, school-level economic disadvantage. **Individual-level:** Age, sex, ethnicity/race urbanicity	**Decile ratio:** P80/P20 **Range:** Decile ratio: 2.13 to 26.10 Gini: 0.25 to 0.73	In univariate models, income inequality was significantly associated with psychological distress β = 0.154 (S.E. = 0.0735, p<0.05). In fully adjusted model income inequality was not significantly associated with psychological distress β = 0.0689 (S.E. = 0.0764).	**Interaction:** N/A **Mediation:** N/A
Dierckens et al 2020[96]	17 countries N = 48 country/year groups Age: 11, 13, 15	N = 48 country/year groups Pooled time series	Prais-Winsten times series regression models	Psychological symptoms The absolute difference in psychological symptoms between the high and low socioeconomic status (SES) groups HBSC symptom checklist	**Country-level:** Gross national income, wealth inequality, sex, age	Gini coefficient **Range by year:** 2010 = 0.29 2014 = 0.30 2018 = 0.30	Country level income inequality was associated with higher average psychological symptoms β = 4.46 (95%CI: 1.36 to 7.55, p=0.005). Country level income inequality was associated with higher psychological symptoms between the higher and lower SES groups β = 2.50 (95%CI: 1.47 to 3.54, p<.001).	**Interaction:** N/A **Mediation:** N/A

Note: †ICC = Intraclass correlation coefficient = the amount of variation in the outcome of interest attributable to between cluster differences.[99]

Method for conducting literature review can be found in Appendix B.

3.3 Income inequality and behaviour problems

A synopsis of the literature is in <u>table 2</u>. The table gives author, sample, location, age of the sample, area unit of investigation, study design, outcome measure and the tool, covariates, income inequality measure and range, key findings of the study, and whether there was evidence of interaction or mediation or if interaction or mediation was tested.

3.3.1 Study characteristics

In total 8 studies were identified that met the criteria examining income inequality and children or adolescent behaviour problems. The location of the studies included USA (n = 3), Canada (n = 2), and the remaining 3 studies used pooled country data from, 23 countries,[29] 37 countries,[100] and 40 countries.[81] Study designs included, cross-sectional (n = 6),[86,92,93,100,101] with one of the cross-sectional studies also using an ecological design,[100] series cross-sectional (n = 1),[81] and ecological (n = 1).[29] The age range of the samples was 10-19 years of age, which concludes no current studies have used samples investigating contextual income inequality in samples of children younger than 10 years. This lack of evidence in younger populations provides a clear gap in the literature that needs to be filled.

Survey tools assessing behaviour problems varied across the studies. The reported tools were, problem behaviour frequency scale (n = 1),[88] not specified (n = 2),[93,101] composite international diagnostic interview using DSM-IV (n=1),[86] bully victim questionnaire from the HBSC study (n = 2),[81,100] behaviour checklist (n = 1),[92] UNICEF index (n = 1).[29] The outcomes measured included, attacking someone in their neighbourhood (n = 1),[101] involved in fighting (n = 1),[29] anger (n = 1),[93] physical aggression, hyperactivity/inattention (n = 1),[92] conduct problems (n = 1),[88] disruptive behaviours which was defined as a class of disorders diagnosed using the

DSM-IV clinical criteria for a mental disorders (n = 1),[86] and the number of times students

bullied others (n = 2).[81,100]

Methods for calculating income inequality were heterogenous across the 8 studies. The

most common calculation was the Gini coefficient (n = 5).[81,86,92,100,101] Two studies used the

P80/20 ratio (n = 2),[29,88] and the coefficient of variation (n = 1).[93] Similar to emotional problems

the most used statistical method was multilevel regression models (n = 5),[81,88,92,93,100,101] and one

of the multilevel model studies also used linear regression as a part of their study design to

investigate income inequality ecologically.[92] Two studies did not use multilevel regression

models, and instead used Pearson correlation (n = 1),[29] and logistic regression (n = 1).[86]

3.3.2 Supportive studies

In total, 3 studies identified were in support of the contextual income inequality hypothesis,

that is, the greater the disparities between the rich and the poor in a defined area, the greater the

symptoms of worse behaviour problems compared to individuals living in areas with less income

inequality. In ecological studies, Elgar et al,[100] showed that country-level income inequality was

significantly correlated with bullying others in both males and females. In the same study using

individual outcomes, country-level income inequality was significantly associated with bullying

others in both males and females, after adjusting for country and individual-level confounders.[100]

Similarly, Elgar et al,[81] found in their sex-stratified time series analysis across 40 countries, that

exposure to country-level income inequality during early life (0-4 years of age) was not

significantly associated with bullying others in boys or girls in adolescents. However, the study

did observe an association between early life exposure to income inequality (0-4 years) and dual

involvement in bullying others and being bullied in adolescences in both boys and girls,

controlling for lifetime income inequality and other confounders.[81]

In smaller geographical units like census tracts, Quon et al,[93] showed that census-tract level income inequality was significantly associated with anger in univariate models. This relationship remained significant after controlling for SES, school district income, and household income.[93] In another study by, Quon et al,[92] the authors did not observe an association between provincial-level income inequality and physical aggression or hyperactivity/inattention. However, in the same study, cross-level interactions between province income inequality and parental education were observed to be significantly associated with adolescent hyperactivity/inattention symptoms. That is to say, provincial income inequality is modified by the individual effect of socioeconomic status, for hyperactivity/inattention disorders in adolescents.[92]

3.3.3 Unsupportive studies

The remaining 5 studies were not in support of the contextual income inequality hypothesis. Beginning with the largest area unit—countries, Pickett & Wilkinson,[29] did not observe an association between country-level income inequality and being involved in fighting in a sample of 0–17-year-olds across 23 rich countries.

In studies analyzing census tract income inequality, Pabayo et al,[101] observed that census tract income inequality has no significant association with attacking someone in their neighbourhood in either boys or girls.[101] The same study examined the bivariate association between individual social cohesion as a potential mediating factor and physical aggression. Results showed income inequality was not associated with either social cohesion, nor was social cohesion associated with adolescent physical aggression.[101] In another USA-based study, McLaughlin et al,[86] found in fully adjusted models that income inequality was not associated with a past 12-month DSM-IV disorder. When models were stratified by DSM-IV disorder, census-tract income inequality was not associated with disruptive behaviour disorders in

adolescents, controlling for relative SES, parental education and family income.[86] A similar relationship was observed by, Rivenbark et al,[88] where census tract-level income inequality was not associated with conduct disorders in adolescents, in either univariate models, or fully adjusted models.

The reported studies in the analysis have the following limitations. The first limitation as discussed above is the ecological fallacy limiting the interpretation of ecological studies to individual health outcomes. The second, residual confounding with the failure to include individual household income in regression models. It is argued elsewhere, to isolate the contextual effects of income inequality, the need to control for household income is vital.[23] In total 3 cross-sectional studies did not include household income in their analysis,[88,100,101] however, the exposure of interest (income inequality) was not insignificant for 2 of the studies.[88,101]

In summary, there is mixed evidence that contextual income inequality is associated with symptoms of behavioural problems among adolescents. Perhaps the lack of congruency in the outcome measured across the 8 studies is responsible for the mixed findings. For instance, the case definition used for this descriptive analysis was to use bullying or violence as a proxy for conduct disorders or physical aggression. The poor choice of proxy may have led to including studies that may not be appropriate in understanding the contextual effect of income inequality on disorders like physical aggression, attention-deficit disorders or conduct disorders.

Social capital/cohesion as a mediator in the contextual income inequality and health relationship is not supported by the evidence,[101] however, further investigation may be warranted. No studies, including the Canadian-based studies in this descriptive analysis, evaluated contextual income inequality and preschooler's behavioural problems. One study did

investigate the long-term effects of early life exposure to income inequality, however, the study used country-level income inequality as the exposure.[81] No studies using the Canadian setting, investigating neighbourhood income inequality and preschool-aged children's behavioural problems exist. Therefore, areas to fill would include investigating behavioural outcomes in children other than bullying, like physical aggression, attention-deficit and/or hyperactivity/inattention, conduct disorder, or oppositional defiant disorder. Investigating income inequality at the neighbourhood level and examining the association with behaviour problems may be more appropriate for this young age, as the potential relationship between income inequality and maternal mental health may influence child development.

Table 2 Literature examining income inequality and behavioural problems amongst children and adolescents (n = 8)

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Rivenbark et al[88]	North Carolina, USA N = 1,927 adolescents Age: 10-16	Census tract Cross-sectional	Multiple linear regression	Conduct problems Problem Behavior Frequency Scale	**Area-level:** Median neighbourhood income, family economic disadvantage, school-level economic disadvantage. **Individual-level:** Age, sex, ethnicity/race urbanicity	**Decile ratio:** P80/P20 Gini coefficient **Decile ratio range:** 2.13 to 26.10 **Gini coefficient range:** 0.25 to 0.73	In the univariate models there was no association between income inequality and conduct problems β = 0.0120 (S.E. = 0.00690). In fully adjusted models, there was no association between income inequality and conduct problems β = 0.00772 (S.E. = 0.00633).	**Interaction:** No interaction tested **Mediation:** No mediation tested
Elgar et al 2019	40 Countries n = 425,938 male n = 448,265 female adolescents Age: 11, 13, 15	N = 162 country survey/year groups Pooled time series cross-sectional	Multilevel models (4 levels)	Bullying others Bullying-victim questionnaire	**Country (level 4):** Gross national income per capita (GNI) **Country years (level 3):** Time*GNI, time*Gini, time **Schools (level 2):** None **Individual-level (level 1):** Socioeconomic position (SEP), differences in age	Gini index **Range:** 0.16-0.45	In fully adjusted models, early life exposure to income inequality was not significant associated with bullying others in boys β = 4.09 (95%CI: -4.57 to 12.75) or girls β = -0.93 (95%CI: -5.05 to 3.18) in adolescents. However, in fully adjusted models, early life income inequality (0-4 years of age) was associated with combined (bullying + victimisation) bullying outcomes in adolescents for boys β = 5.55 (95%CI: 2.67 to 8.44) and girls β = 2.45 (95%CI: 0.93 to 3.97), controlling for lifetime income inequality.	**Interaction:** N/A **Mediation:** N/A

Table 2 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Elgar et al 2009[100]	37 countries N = 66,817 Age: 11	N = 37 countries Cross-sectional & ecological	Multilevel ordinal models Multilevel linear regression Linear regression	Bullying others Bullying-victim questionnaire from HBSC study	**Area-level:** Gross domestic product per capita, individual wealth, family support, peer support, school support	Gini index **Range:** 0.247-0.436	**Ecological correlations:** Country income inequality was significantly correlated with bullying for both males r = 0.58 (p<0.01) and females r = -0.64 (p<0.01). **Multilevel:** In the multilevel models, country level income inequality was significantly associated with bullying others for both males OR = 1.17 (95%CI: 1.12-1.21) and females OR = 1.24 (95%CI: 1.19-1.29), after controlling for country GDP and individual wealth.	**Interaction:** N/A **Mediation:** N/A
Quon et al 2015[93]	Quebec, Canada N = 2,199 adolescents Age: 13-16	N = 49 School districts Cross-sectional	Multilevel linear regression (2 levels)	Anger	**Area-level:** School education/employment index (SES at school level), school poverty rate, school district income (median household income). **Individual-level:** Age, sex, subjective socioeconomic status (SES), household income, parent education, district income.	Coefficient of variation **Range:** Not specified	Univariately, an increase in income inequality was associated with greater anger symptoms β = -0.6 (p<0.001). In fully adjusted multilevel models, income inequality remained significantly associated with anger β = -0.6 (p<0.05), although the significance attenuated.	**Interaction:** N/A **Mediation:** N/A

41

Table 2 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
McLaughlin et al 2012[86]	USA N = 6,483 adolescents Age: 13-17	Census tract Cross-sectional	Logistic regression	**One class of disorder:** Disruptive behaviour disorders (i.e., attention-deficit/hyperactivity disorder, oppositional-defiant) Composite International Diagnostic Interview using criteria of Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV).	**Area-level:** Relative deprivation. **Individual-level:** Parental educational attainment, household income, subjective social status, age, gender, race/ethnicity.	Gini coefficient **Range:** Not specified	In fully adjusted multivariate models, census tract level income inequality was not associated with an indication of 12-month DSM-IV disorder in adolescents OR = 1.0 (95%CI: 0.9 to 1.0, p>0.05) In fully adjusted models, census tract income inequality was not associated with disruptive behaviour disorders in adolescents OR = 1.0 (95%CI: 0.9 to 1.0, p>0.05).	**Interaction:** N/A **Mediation:** N/A
Quon et al 2014[92]	Canada N = 11,899 adolescents Age: 12-17	Provinces Cross-sectional	Multilevel linear models (2 levels)	Physical aggression, hyperactivity/inattention Behaviour checklist	**Area-level (province year):** Mean income after tax **Individual-level:** Household income, parental education, sex, age	Gini coefficient **Range (across Provinces):** 2000 = 0.285-0.325 2006 = 0.265-0.323	In fully adjusted models, province level income inequality was not associated with adolescent physical aggression problems: β = 0.001 (95%CI: -0.06 to 0.06, p>0.05), hyperactivity/inattention β = -0.005 (95%CI: -0.05 to 0.05, p>0.05)	**Interaction:** In the fully adjusted model, higher income inequality and lower parental education was significantly associated with hyperactivity/inattention disorders β = -0.024 (95%CI: -0.04 to -0.004, p<0.05).

Table 2 Continued

Authors	Location & sample	Area unit & study design	Statistical method	Outcome(s) & measure	Covariates:	Inequality measure & range	Key findings:	Evidence of interaction or mediation
Pickett & Wilkinson 2007[29]	23 rich countries & 50 US States Age: 0-17	N = 50 US States & N = 23 countries Ecological	Pearson correlation	Involved in fighting UNICEF index	None	**Decile ratio:** P20/P20 Range: 3.4 (Japan) to 8.55 (USA)	**Sample of 27 countries:** Country level income inequality was not significantly correlated and being involved in fighting in children and youth r= -0.20 (p=0.39). **Sample of 50 USA States:** Across 50 USA states and the District of Columbia, higher income inequality was correlated with juvenile homicides r = 0.31 (p=0.03).	**Interaction:** N/A **Mediation:** N/A
Pabayo et al 2014[101]	Boston, USA N = 1,878 adolescents Age: 13-19	Census tracts Cross-sectional	Multilevel linear models (2 levels)	Attacked someone in their neighbourhood with a weapon other than a gun	**Area-level:** Economic deprivation, neighbourhood danger, neighbourhood disorder, proportion black **Individual-level:** Age, US born, race	Gini coefficient **Range:** 0.28 to 0.59	**Sex-stratified analysis:** **Boys (n=652):** In fully adjusted models, neighbourhood income inequality was not associated with attacking someone in their neighbourhood among boys OR = 2.48 (95%CI: 1.23 to 5.02). **Girls (n=791):** In fully adjusted models, neighbourhood income inequality was not associated with attacking someone in their neighbourhood among girls OR = 1.65 (95%CI: 0.69 to 3.93).	**Interaction:** N/A **Mediation:** Social cohesion was not related to either boys OR = 0.65 (95%CI: 0.32 to1.32) or girls OR = 0.61 (95%CI: 0.36 to 1.03) likelihood of attacking someone in their neighbourhood.

Note: †ICC = Intraclass correlation coefficient = the amount of variation in the outcome of interest attributable to between cluster differences.[99]

Method for conducting literature review can be found in Appendix B.

3.4 Conclusion

In the area of neighbourhood contextual determinants and preschool-aged children's development, there remains a clear gap—income inequality. Evidence suggests other neighbourhood economic and social characteristics are an important consideration for the health and development of preschoolers. Neighbourhoods with more social ties, and less socio-economic deprivation may promote a decrease in emotional and behavioural problems in preschoolers.

The analytic part of this thesis will add to the literature on income inequality and child health outcomes by, investigating neighbourhoods rather than larger area units and use specific cross-sectional data on preschoolers at age 3 to establish if there is a relationship between neighbourhood income inequality and emotional and behavioural maladjustment. This study will serve to provide a preliminary understanding of child exposure to neighbourhood income inequality and its potential influence on emotional and behavioural development cross-sectionally.

4. Manuscript

Title: Neighbourhood income inequality and internalizing and externalizing problems at 3-years of age

Gregory Farmer, School of public health, University of Alberta, Edmonton, Canada

Sheila W MacDonald, PhD, Department of Pediatrics and Community Health Sciences, Cumming School of Medicine, University of Calgary, Calgary, Canada.

Shelby Yamamoto, PhD, School of public health, University of Alberta, Edmonton, Canada

Chris Wilkes, MB, ChB, M.Phil, DCH, FRCP (edin), MRC Psych, FRCP(C), FAPA, Department of Psychiatry, Cumming School of Medicine, University of Calgary, Calgary, Canada.

Roman Pabayo, PhD, School of public health, University of Alberta, Edmonton, Canada,

Ethics Approval: Ethics approval was granted from the University of Alberta Research Ethics Board under the study ID Pro00083081.

Conflicts of interests and declarations: Roman Pabayo is a Tier II Canada Research Chair. The authors have no conflicts of interest to report.

4.1 Abstract

Background Several studies have linked neighbourhood social and economic characteristics to preschool-aged children's behavioural problems. Although income inequality has been identified as a risk factor for mental health and behavioural outcomes among adolescents, few studies have been conducted on children younger than 10 years of age. The objective of the current study is to explore the association between neighbourhood-level income inequality and internalizing and externalizing problems among preschool-aged children.

Methods We analyzed cross-sectional data from the All Our Families (AOF) longitudinal cohort located in Calgary, Alberta at 3-years postpartum. The analytical sample consisted of 1598 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 of their child. Multilevel logistic regression modelling was used to assess a relationship between neighbourhood income inequality measured via the Gini coefficient and preschooler's internalizing and externalizing problems.

Results The mean Gini coefficient across the 184 neighbourhoods was 0.33 (S.D = 0.05) and ranged from 0.23 to 0.55. Neighbourhood income inequality was not associated with either externalizing (OR = 1.04, 95% CI: 0.89, 1.20) or internalizing (OR = 0.96, 95% CI: 0.84, 1.14) problems in preschoolers. Before-tax household income was significant in internalizing (OR = 1.38, 95% CI: 1.02, 1.86), however, was not significant for externalizing problems in fully adjusted models.

Conclusion Neighbourhood-level inequality is not associated with preschool internalizing or externalizing problems at 3-years of age. Income inequality may not have an impact on preschoolers because they may be too young to experience its effects or are more sensitive to the

household environment such as lower household incomes, as opposed to their neighbourhood

environment.

4.2 Introduction

In Canadian representative samples, the prevalence of emotional and behavioural problems is estimated to be 18%, among 4-11 year-old children.[7] In other samples restricted to only the investigation of preschoolers (3-4 years of age), prevalence estimates of emotional and behaviour problems ranged from 7-25% in several community samples.[15] Emotional and behavioural problems in preschool-aged years of development are concerning as these disorders are risk factors for adolescent mental health problems (internalizing and externalizing problems).[17] Subsequently, pre-adolescent and adolescent emotional problems and behavioural problems is a risk factor for juvenile delinquency,[18] premature mortality,[19] and high school non-completion.[20]

Risk factors for emotional and behavioural problems in children are maternal depression, child sex, child temperament, and low maternal education.[39] However, in addition to a child or maternal characteristics, the Social Determinants of Health Framework posits that conditions of the social, physical, and economic environment may play a role to influence a child's mental health.[22]

One feature of the socio-economic environment is income inequality, which 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,[62] which has been identified as a determinant of normal development and health in the population.[61]

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.[28] Another study observed higher income inequality during early life (0-4 years) leads to more bullying perpetration and victimization in adolescences across 40 countries.[81] Furthermore, a pooled

analysis across 50 U.S. states determined that greater state-level income inequality was associated with mental health problems amongst children 0-17 years of age.[29] Similarly, the long term effect of income inequality at 4-5 years of age is associated with worse overall well-being in adolescence.[82]

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.[70] An erosion of social cohesion if characterized by areas with higher income inequality may lead to greater mistrust between members of society, reduced social participation and social group membership.[72] A lack of societal or community social cohesion may generate social isolation, alienation and loneliness, leading to depression.[25,76,77] In child studies, less social cohesion and low collective efficacy are associated with greater emotional or behavioural problems in children.[51,59]

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.[73] Worrying about status and location within the status hierarchy can lead to more stress, feelings of inferiority, and shame, and can lead to depression.[73,75] Evidence from the United States demonstrates that higher US state-level income inequality has also been linked with depression among women.[83] Findings from another study indicate that state-level income inequality was associated with an increased likelihood of experiencing depression only among mothers of low-income.[31] This relationship between income inequality and depression may be strikingly detrimental to maternal mental health which in turn might affect the health of their preschool-aged children. For example, maternal depressive symptoms are associated with the increased likelihood of preschooler's emotional and

behavioural disorders.[32] Thus, it is plausible that preschool-aged children may experience the effects of inequality, however, even if the exact mechanism of action from income inequality to preschool-aged children's health remains to be investigated.

To our knowledge, no studies investigating neighbourhood income inequality and emotional and behavioural problems among preschool-aged children have been conducted. The current study will address the gaps in the literature by investigating neighbourhood income inequality and emotional and behavioural problems using a sample of 1598 3-year-old children living in Calgary, Canada. We hypothesize that greater neighbourhood income inequality is associated with an increased likelihood for emotional and behavioural problems in preschool-aged children.

4.3 Methods

Data Access

Data for the study was obtained through PolicyWise for Children & Families through their Secondary Analysis to Generate Evidence database (SAGE). SAGE is a data repository only accessible through a virtual network by a two-step authentication process. A requirement for all analysis leaving the secure virtual network was through data vetting by trained PolicyWise staff members to ensure confidentiality before results could be used outside the portal. All individuals accessing data needed to undergo a training session with PolicyWise staff and sign a user agreement.

Data Sources

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.[102,103] Briefly, women were

recruited from laboratory serology clinics, primary care clinics, or through posters/word of mouth. A total of 3387 women were enrolled at baseline between May 2008 to May 2011 and met the following inclusion criteria; women need to be at least 18 years of age, be able to understand and speak English, be less than 25 weeks pregnant at recruitment date.[102]

After childbirth, mothers were invited for follow-up at 4 months, and 1, 2, 3-years postpartum, at which point data on the child's behaviour, and postpartum depressive symptoms were collected.[102] The current study uses data at 3-years postpartum which included 69% (1993/3337) of mothers who started the study (see figure 4).[102] From baseline to 3-years postpartum, 28% of the sample was lost to follow-up, which resulted from passive withdrawal (20%), active withdrawal (7%), and pregnancy loss/child death (1%).[102]

Figure 4 AOF cohort participant follow-up
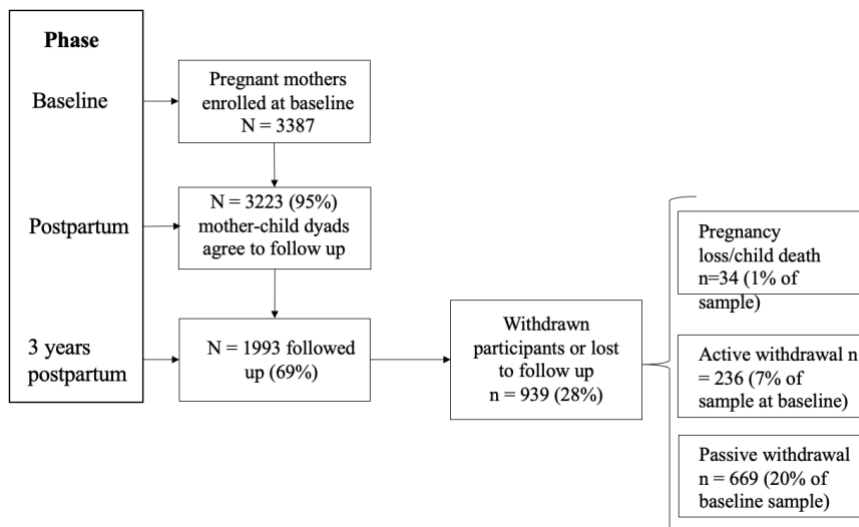
Note: Figure is adapted from.[102]

Neighbourhoods

To measure neighbourhood variables, data were obtained from Statistics Canada for the 2006 Census dissemination areas. Dissemination areas (DA) is the smallest area unit used by Statistics Canada and contains a population of about 400 to 700 individuals.[104] Dissemination area-level data for the City of Calgary was then amalgamated to defined neighbourhoods to produce "neighbourhood-level" structural characteristics (e.g., percentage visible minority) Neighbourhood boundaries were defined using boundaries set by the 2011 National Household Survey (NHS).[105] 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.

Data exclusion

To handle missing data at the neighbourhood-level and individual-level, any missing data was deleted. AOF mothers who at baseline lived in an industrial area, an area with an undefined boundary/ area too new, did not have available neighbourhood data, and therefore were excluded. This resulted in a total of 8.8% = (299/3387) of the sample being excluded due to missing data (see figure 5). The data exclusion also affected the number of neighbourhoods, with 89% (184/206) of neighbourhoods being retained. Using a test of two proportions, those excluded were no different in ethnicity, education, household income level, or marital status compared to those retained.

Figure 5 Flowchart of case-complete dataset used for analyzing data
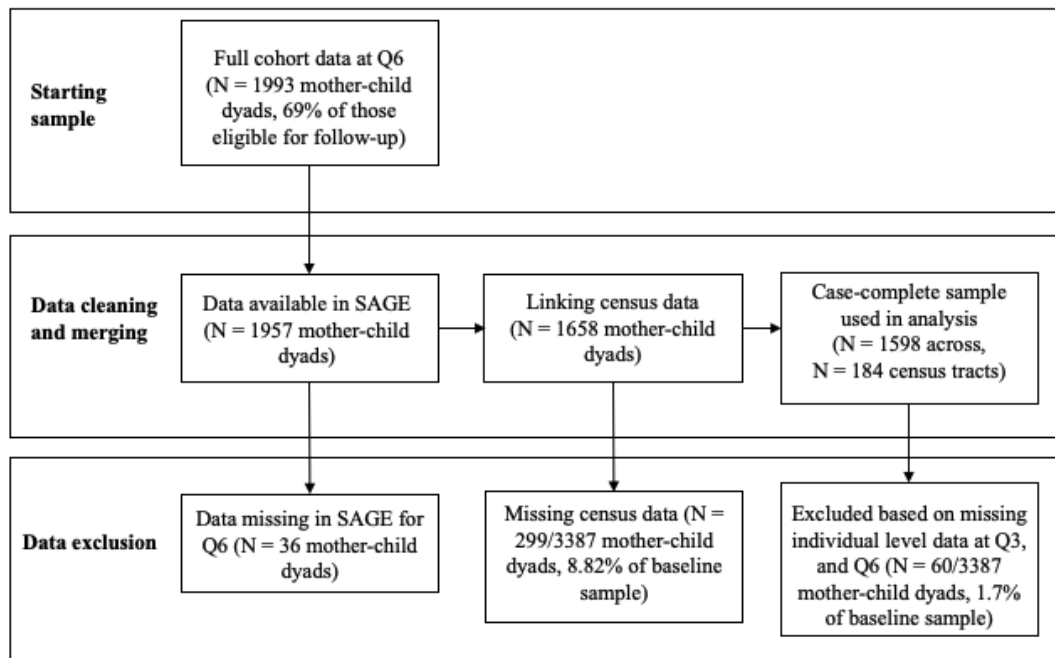
At the individual-level, a total of 1.7% = (60/3387) participants were missing relevant data on child outcomes, maternal ethnicity, and sex of the child at birth and were therefore excluded. Due to very low missingness, multiple imputations were not feasible, and furthermore, missing data less than 5% has been hypothesized not to incur substantial bias.[106] Again using a test of two proportions, the characteristics of those excluded were no different in terms of ethnicity, education, household income level, or marital status compared to those retained. The final sample analyzed in this associational study consisted of 1598 (47% of mothers at baseline) mother-child dyads nested within 184 neighbourhoods in Calgary, Alberta.

Income Inequality

To generate the Gini coefficient, available data on after-tax household income classified into income bins (e.g., $30,000-$39,999 CAD) for Calgary dissemination areas were obtained from Statistics Canada for the 2006 census. Household income was reported into $10,000CAD bins ranging from: under $10,000CAD to over $100,000CAD (D. Reynard, MGIS, written document, February 27, 2019). To assign a limit to the largest bin, all incomes were summated from the closed bins and added to the mean household income for the dissemination area (D. Reynard, MGIS, written document, February 27, 2019). Then all households in the top bins were assigned the mean of this extra income (D. Reynard, MGIS, written document, February 27, 2019).

Next, a health geographer used cumulative distribution function (CDF) interpolation,[107] and compared the CDF to a straight line of perfect equality, and the ratio of departure from the two lines is calculated (see section 2.2 for calculation).[23] All computations for the Gini coefficient were completed in the R library using the binsmooth package.[108]

As discussed in section 2.2, 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.[63] 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.[63] The Gini coefficient was standardized using a Z-transformation for ease of interpretation.

Preschooler Outcomes

Preschoolers' emotional and behaviour problems were measured using the National Longitudinal Survey of Children and Youth adapted short form Child Behaviour Checklist (NLSCY-CBCL),[5] which was adapted from the original CBCL.[109] The NLSCY-CBCL measures

2 global domains; internalizing, and externalizing problems. Internalizing problems are comprised of emotional/anxiety and separation anxiety problems, while externalizing problems are comprised of physical aggression and hyperactivity/inattention problems. The development of this survey tool has been described elsewhere.[5]

Briefly, for emotional/anxiety subscales, the NLSCY developed this scale using 6 items from the Ontario Child Health Study (OCHS).[6] In the OCHS study, Boyle et al, had psychiatrists choose items from the original CBCL which reflect elements of DSM-III categories for overanxious disorders, obsessive-compulsive disorders, and affective disorders to construct the outcome emotional problems.[6] For the separation anxiety scale, 5 items came from Achenbach's child behaviour checklist.[73] Physical aggression subscale included two domains: physical aggression and opposition subscales.[73] Two of the three questions making up the physical aggression subscale were derived from the OCHS, with the final question coming from the Montreal Longitudinal Survey (MLS).[73] The remaining 5 items coming from Achenbach's CBCL.[73] Due to overlapping questions with the oppositional-defiant disorder scale one question of the physical aggression scale was dropped. The last scale is hyperactivity/inattention which is comprised of 6 items from the MLS.[73]

In the questionnaire, mothers were asked "How often in a typical week does your child: "seem happy sad or depressed"; "clings to adults or is too dependent"; "get into fights"; and "can't sit still or is restless" respectively. In total 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 somewhat true rated as 1, often or very true rated as 2. Survey responses were summed to generate a mean score for each subdomain.

To classify children as high or low symptomatology, the full-length CBCL has a manual with normative data for the various subscales which enables the use of validated cut-off scores.[8] The adaptation of the CBCL reduced the number of total items, as such, the survey used in the NLSCY adapted form is not based on the original scales of the CBCL. Therefore, it is not possible to utilize normative values to dichotomize the subscales.[44] To determine cut-off scores for the proposed study, previous studies scoring the NLSCY adapted CBCL were consulted. Two studies using AOF data used 1 standard deviation above the mean as a cut-off value to classify children as "at-risk" for behaviour problems, which has been previously stated to be consistent with full-length CBCL algorithm using the 84th percentile as a cut-off.[44,46] Therefore, this cut-off was used to classify children above 1 standard deviation (SD) above the mean to be "at-risk" for all 4 subdomains.[9] Children "at-risk" for either subdomain (i.e., physical aggression or hyperactivity/inattention) were categorized as 1, and if children fell below this threshold for BOTH subdomains they were categorized as 0.[46] This aforementioned method is consistent with the literature on preschoolers psychopathology using AOF data studying externalizing problems.[44] The same method was applied to internalizing problems.

Validity

To ensure quality control, the validity of the CBCL was assessed in the literature. Validity is defined as the ability of a test to distinguish between who has the disease and who does not.[110] Currently, no validity studies examining the NLSCY-CBCL in the specific aged population of preschoolers are available. An exception is hyperactivity/inattention scales, where a study by, Charach et al, estimated using a sample of 6-11 year-olds from the 1994/1995 survey cycle of the NLSCY observed that the hyperactivity/inattention scale was sufficient at indicating high

symptoms of ADHD as identified through methylphenidate use and diagnosed emotional disorder in a large population sample.[111]

For the emotional/anxiety subscale of the NLSCY-CBCL which is comprised of items from the OCHS, Boyle et al,[6] tested the agreement between the parent completed checklists compared to psychiatrist diagnosis in a sample of 4–11 year-olds. The resulting agreement between psychiatric diagnosis (the gold standard in this case) and the checklist was moderate (k = 0.53). The specificity of the test was high at 89%, while the sensitivity was very low at 6%. A high specificity with a low sensitivity will keep the number of false negatives and false positives in the sample equivalent, which will limit the error rate because the overall prevalence of emotional problems in children and adolescents in the general population is low.[111]

Reliability

Unlike the validity of the NLSCY-CBCL, the reliability or internal consistency has been well documented. Reliability is defined as the extent to which the results obtained by a test are replicated if the test is repeated.[110] One measure of reliability is Cronbach's alpha.[112] The Cronbach's alpha is a measure of internal consistency which seeks to measure the magnitude the items of a survey are correlated with each other.[113] A Cronbach's alpha value over $\alpha = 0.70$, is used as a good measure of internal consistency if the aim is to compare groups, and not for diagnostic purposes.[113] Overall, the physical aggression ($\alpha = 0.74$) and hyperactivity/inattention ($\alpha = 0.80$) scales showed good internal consistency meeting the 0.70 threshold, while the separation anxiety ($\alpha = 0.59$) and emotional/anxiety ($\alpha = 0.61$) problems showed poor reliability (see table in the Appendix C). The reported Cronbach's alpha estimates are akin to those in published studies using AOF data.[44,114]

Covariates

Variables included in statistical models to control for potential confounding were, mothers'

ethnicity measured at baseline, dichotomized into 0 = Caucasian and 1 = visible minority.

Child's biological sex measured at birth, dichotomized into 0 = female and 1 = male. Mother's

educational attainment to date, dichotomized into 0 = graduated post-secondary or more, and 1 =

some post-secondary or less. Self-reported before-tax household income at 3-years postpartum

dichotomized into, 1 = less than $80,000 CAD and 0 = greater than or equal to $80,000 CAD.

Marital status at 3-years postpartum was also included and dichotomized into, 0 = married or

coupled and 1 = single. The justification for individual-level covariates came from the

recommendation by Leventhal & Brooks-Gunn,[21] to control for key socio-demographic variables

to isolate for contextual neighbourhood effects.

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.

Proportion below the low-income cut-off (LICO), a Statistics Canada-derived measure, which

quantifies the proportion of homes spending 20% more of income on necessities like food,

clothing, or shelter than the average and thus may experience economic stress.[115] 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 for ease of

interpretation.

4.4 Statistical analysis

Descriptive statistics for all variables were conducted to investigate data normality. Next,

pairwise correlations comparing all neighbourhood-level variables of interest were used to

investigate the bivariate relationships and assess possible multicollinearity (see table in

Appendix F). Since preschool children were nested within neighbourhoods, we used multilevel modelling to test the relationship between neighbourhood income inequality and internalizing and externalizing problems.[116] The following method was used to fit 6 models, 3 each for each outcome. First, an intercept-only model (not shown) was fit to the data, and the variance in emotional and behavioural outcomes across the 184 neighbourhoods was determined using a 95% plausible value range (see Appendix E for formula).[116] The 95% plausible value range indicates the variation in the proportion estimates in the sample across the 184 neighbourhoods and is provided in the results section of the paper.[116] Second, a crude model with only income inequality was fit to the data to assess the bivariate relationship between income inequality and internalizing and externalizing problems. At this stage a cross-level interaction term biological sex*Gini coefficient was added to the model to determine if stratifying by sex in the analysis would be necessary. The interaction term *biological sex*Gini coefficient* was insignificant, therefore, an analysis using the full sample was conducted. Third, individual-level covariates were added, followed by neighbourhood-level covariates. At this stage a second interaction term *household income*Gini coefficient* was added to the model to test whether there would be cross-level interactions between individual earned income and area level inequality. The interaction term *household income*Gini coefficient* was insignificant, therefore, was not included in the results section. All statistical analyses were completed using STATA version 15.1®.[117] To evaluate the relationships, a two-sided p-value of $\alpha \leq 0.05$ was used.

A sensitivity analysis was conducted to determine if using the 4 subscales of internalizing: emotional/anxiety problems; separation anxiety problems, and externalizing: physical aggression problems; and hyperactivity/inattention problems would yield different results compared to using two generalized domains. Results for sensitivity analysis can be found in Appendix G and H.

4.5 Results

Characteristics of the 1598 mother-child dyads at 3-years postpartum are given in table 3.

Overall, the sample contains more male preschoolers (52.6%) than females. Many of the mothers

were Caucasian (81.0%), were married/coupled (95.1%), made more than $80,000 CAD per

annum (78.4%), and have graduated from a post-secondary institution (81.9%).

Table 3 Sociodemographic characteristics (n=1598) mother-child dyads
and neighbourhoods (n=184) from the AOF sample

Variable	n	%
Emotional/anxiety	163	9.8
Separation anxiety	323	19.5
Physical aggression	211	12.8
Hyperactivity/inattention	272	16.5
Sex		
Female	770	47.4
Male	853	52.6
Maternal age		
<35 years	832	49.8
≥35 years	826	50.2
Marital status		
Married/common-law	1577	95.1
Single/other	81	4.9
Mother's ethnicity		
Caucasian	1355	81.0
Non-Caucasian	313	19.0
Household income		
Less than $80,000 annually	355	21.6
Greater than $80,000 annually	1286	78.4
Parental education		
Some post-secondary or less	1358	81.9
Graduated post-secondary or more	300	18.1
Variable	**Mean (SD)**	**Range**
Neighbourhood characteristics (n=184)		
Gini coefficient	0.33 (0.05)	0.20-0.55
Proportion visible minority	0.21 (0.14)	0-0.82

Proportion recent immigrant	0.06 (0.04)	0-0.27
Below LICO[†]	0.04 (0.04)	0-0.53
Proportion >over100k	0.32 (0.14)	0.03-0.76

Note: † LICO = Low-income cut-off.

Descriptive statistics can also be found in table 3 for preschooler's outcome variables. In the sample, the proportion of children experiencing emotional/anxiety problems was 9.8%, and 19.5% for separation anxiety problems which amounted to an overall prevalence of 24.8% for internalizing problems. For externalizing problems, the overall prevalence was 24.2%, with 12.8% of the sample experiencing symptoms of physical aggression, and 16.5% of the sample experiencing hyperactivity/inattention problems.

Descriptive statistics for the 184 neighbourhoods in Calgary can be found in table 3. The average Gini coefficient across the 184 neighbourhoods in Calgary was 0.33 (SD = 0.05; range 0.20-0.55). 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.[65] 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 variation in preschooler's outcomes across the neighbourhoods assessed using the 95% plausible value range showed modest variation with internalizing (14.9%-37.6%) and externalizing (11.95%-26.4%) problems.

The results of the statistical analysis are shown in table 4. Univariate models (model 1 and 4) demonstrate a non-statistically significant relationship between neighbourhood income inequality and either internalizing (OR = 0.95, 95% CI: 0.83,1.08) or externalizing (OR = 0.99, 95% CI: 0.88,1.13) problems at 3-years of age. This insignificant relationship remained when individual-level confounders was added to the model for either internalizing (OR = 0.97, 95% CI: 0.86,1.11) or externalizing problems (OR = 1.01, 95%CI: 0.88,1.14), and when

neighbourhood-level confounders were added to the models, internalizing (OR = 0.96, 95% CI: 0.84,1.14) and externalizing problems (OR = 1.04, 95% CI: 0.89,1.20) remained insignificant.

In fully adjusted models (model 3 and 6), lower household income (below $80,000 CAD) was associated with a 38% increase in odds (OR = 1.38, 95% CI: 1.02,1.86) of being "at-risk" for internalizing problems in 3-year-olds. This relationship, however, was insignificant (OR = 1.35, 95% CI: 1.00,1.82) for being "at-risk" for externalizing problems. Unsurprisingly, boys compared to girls had an increased odds of (OR = 1.29, 95% CI: 1.02,1.64) of being "at-risk" for externalizing problems, controlling for individual and neighbourhood-level confounders.

Table 4 Multilevel logistic models examining associations between neighbourhood income inequality and high-risk behavioural in preschoolers (n=1598) across n=184 neighbourhoods

	Internalizing						Externalizing					
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Neighbourhood Characteristics												
Income inequality (z-score)	0.95	0.83, 1.08	0.97	0.86, 1.11	0.96	0.84, 1.14	0.99	0.88, 1.13	1.01	0.88, 1.14	1.04	0.89, 1.20
Proportion LICO (z-score)					1.04	0.87, 1.23					0.95	0.78, 1.14
Proportion visible minority (z-score)					1.10	0.92, 1.31					1.19	0.99, 1.42
Proportion recent immigrant (z-score)					0.97	0.81, 1.16					0.83	0.69, 1.00
Proportion >100k (z-score)					0.97	0.82, 1.14					0.93	0.79, 1.10
Individual Characteristics												
Household income (ref: greater than $79,999 CAD/year)												
Less than $79,999CAD			**1.44**	**1.07, 1.92**	**1.38**	**1.02, 1.86**			**1.39**	**1.03,1.86**	1.35	1.00, 1.82
Education (ref: post-secondary or more)												
High school			0.98	0.72, 1.35	0.97	0.70, 1.33			1.18	0.87, 1.60	1.17	0.86, 1.59
Marital status (ref: coupled)												
Single			1.56	0.94, 2.60	1.53	0.92, 2.55			0.98	0.57, 1.68	0.99	0.58, 1.70
Mother's ethnicity (ref: white)												
Non-white			**2.07**	**1.57, 2.73**	**1.98**	**1.49, 2.63**			1.03	0.77, 1.39	1.00	0.74, 1.36
Sex of child (ref: female)												
Male			0.89	0.70, 1.21	0.88	0.70, 1.11			**1.29**	**1.02, 1.63**	**1.29**	**1.02, 1.64**

Note: **Bold** indicates a two-sided $\alpha \leq 0.05$.

4.6 Discussion

To our knowledge, this study is the first to examine the association between neighbourhood income inequality and internalizing or externalizing problems among preschool-aged children. Our results suggest that income inequality is not associated with either internalizing or externalizing problems at 3-years of age. Nonetheless, possible key insights into the relationship between income inequality and the population health of young children in Canada are provided.

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.[81] One familial risk factor which could mediate this process, is maternal depressive symptoms. For example, state income inequality is associated with maternal depressive symptoms among women of low income.[31] Another study observed higher state income inequality was associated with greater depressive symptoms among women.[83] Subsequently, maternal depressive symptoms at differing stages of development are associated with greater internalizing and externalizing problems in children,[32] 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.[118] Other researchers observed children of mothers with a history of comorbid depression/anxiety disorders, had a higher likelihood for internalizing problems, among mothers of drug abuse.[119] 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.[120]

One possible reason for not observing a significant relationship between income inequality and emotional and behavioural 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.[121] The strength of the income inequality and morality relationship peaks around 7 years, before diminishing by 12 years post-exposure period.[121] In the case of mental health, US researchers observed 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 2 decades later.[77] These results suggest a substantial lag period between income inequality exposure and mental health-related problems. The limitation in the current study was 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.

The sample of mothers comprising the study is representative of the population of urban parenting families in Calgary, however, they tend to have slightly higher household incomes and education levels when compared to both mothers in Calgary, and the rest of Canada.[102] A higher level of absolute income may have implications on how income inequality is experienced by mothers and their young children.[61] [122] For example, a study in Canada using data from the Canadian Community Health Survey, observed women with a history of mental illness who

possessed low (<$29,999CAD) and middle incomes ($30,000-$79,999CAD) compared to high incomes (>$80,000 CAD), reported experiencing barriers in accessing mental health services (i.e., inadequate transportation to get to and from appointments) or services were not available in their community.[123] It is plausible higher incomes may promote resiliency to income inequality by promoting better mental health, mediated by accessible mental health services, thus mitigating the effect of inequality and its subsequent effect on young children.

Finally, the relationship observed in previous studies may also be contextually dependant. Most of the evidence on the topic comes from the United States which possesses a higher average Gini when compared to Canada. Researchers have theorized that income inequality may not operate as hypothesized in more egalitarian societies.[94,124] Countries such as Canada, spend a higher share of their per capita GDP on social safety nets, as compared to the United States which spends less, and may be more adaptable at handling the effects of inequality.[125] However, the growing income inequality in Canada may allow researchers to soon observe significant findings.

Aside from income inequality, two of the findings in the study were rather unsurprising. The first is the association between lower household income, and preschoolers ' internalizing problems, which is consistent with several studies.[10,47] This finding could have implications for Calgary families, as the chosen threshold to dichotomize after-tax household income, is larger than the median income level for Calgary ($43,400 CAD).[115] Besides household factors, biological factors were significant determinants for externalizing problems in the study. Boys were more likely to exhibit symptoms classified as "at-risk" for externalizing problems when compared to girls and are in line with documented findings in other populations.[10,42]

Limitations

The results of this study should be interpreted with the following limitations. First, a cross-sectional assessment of longitudinal data was used to answer our hypothesis. As such no causal conclusions can be drawn between income inequality and preschooler's emotional and behavioural problems. Second, except for the hyperactivity/inattention subscale,[111] the validity of the NLSCY-CBCL scales used have not been established. Third, the internal consistency of the NLSCY-CBCL is poor, however, utilizing an adapted form of the CBCL allows for the study of emotional and behavioural problems in this population which would otherwise not be possible. Fourth, the questionnaires for children were completed by mothers which may introduce information bias. For example, mothers with greater depressive symptoms are more likely to report symptoms of internalizing or externalizing problems in boys, compared to other informants like group care workers and teachers.[126] Fifth, treating Likert scales (ordinal measure) as a continuous variable when response options are less than 5 may be inappropriate as the mean score is often right-skewed.[127] The scoring method to classify children as "at-risk" in the study is based on the assumption of a standard normal distribution. This issue becomes potentially problematic for the physical aggression subscale which was both right-skewed and leptokurtotic. Sixth, while the cohort is representative of the parenting population in Calgary, participants retained in the study after childbirth were older, more educated and more often married.[102] Seventh, the results observed in this study could be the result of the modifiable areal unit problem (MAUP). The MAUP can occur when conducting research using differing areal units (e.g., neighbourhood versus provinces).[128] 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 Method versus census tracts) changed.[129] Finally, if individuals moved during follow-up between 2006 to 3-years postpartum from a neighbourhood with high inequality to low, this may have resulted in a misclassification of exposure status, as neighbourhood residence during the cohort follow-up was assumed to be invariant. Bearing these limitations in mind, the generalizability of results from the study could be applied to other large metropolitan cities in Canada.

5. Conclusion

In conclusion, the findings from this study demonstrate that income inequality was not associated with preschooler's emotional or behavioural problems at 3-years of age. Although income inequality is not associated with preschooler's outcomes, 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. Additionally, longitudinal investigation at the neighbourhood level is merited. To date two studies have looked at cross-country comparisons showing negative impacts of inequality,[81,82] 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 to determine the contribution of early life income inequality with later life emotional or behavioural problems. Finally, although not common in epidemiologic research, longitudinal structural equation modelling testing the mediating contribution of maternal depression or child maltreatment to determine the specific pathway by which income inequality may be worse for preschooler's health.

References

1. *Diagnostic and statistical manual of mental disorders: DSM-5.* Fifth ed: American Psychiatric Association; 2013.

2. Achenbach TM, Edelbrock CS. *Manual for the child behavior checklist and revised child behavior profile.* T.M. Achenbach; 1983.

3. Poulou MS. Emotional and Behavioural Difficulties in Preschool. *J Child Fam Stud.* 2015;24(2):225. doi:10.1007/s10826-013-9828-9

4. Clark LA, Watson D. Distress and fear disorders: an alternative empirically based taxonomy of the 'mood' and 'anxiety' disorders. *Br J Psychiatry.* 2006;189(6):481-483. doi:10.1192/bjp.bp.106.03825

5. Canada S. National Longitudinal Survey of Children and Youth (NLSCY), Cycle 8 - Microdata User Guide. https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=4450. Published 2010. Accessed October 5, 2021.

6. Boyle MH, Offord DR, Hofmann HG, et al. Ontario child health study. I. Methodology. *Arch Gen Psychiatry.* 1987;44(9):826-831. doi:doi:10.1001/archpsyc.1987.01800210078012

7. Georgiades K, Duncan L, Wang L, Boyle MH, Comeau J. Six-Month Prevalence of Mental Disorders and Service Contacts among Children and Youth in Ontario: Evidence from the 2014 Ontario Child Health Study. *Can J Psychiatry.* 2019;64(4):246-255. doi:10.1177/0706743719830024

8. Wlodarczyk O, Pawils S, Metzner F, et al. Mental Health Problems Among Preschoolers in Germany: Results of the BELLA Preschool Study. *Child Psychiatry Hum Dev.* 2016;47(4):529. doi:10.1007/s10578-015-0586-3

9. Domenech-Llaberia E, Vinas F, Pla E, et al. Prevalence of major depression in preschool children. *Eur Child Adolesc Psychiatry.* 2009;18(10):597-604. doi:10.1007/s00787-009-0019-6

10. Cote SM, Vaillancourt T, Leblanc JC, Nagin DS, Tremblay RE. The development of physical aggression from toddlerhood to pre-adolescence: A nation wide longitudinal study of Canadian children. *J Abnorm Child Psychol.* 2006;34(1):71-85. doi:10.1007/s10802-005-9001-z

11. Hetherington E, McDonald S, Racine N, Tough S. Risk and Protective Factors for Externalizing Behavior at 3 Years: Results from the All Our Families Pregnancy Cohort. *Journal of developmental and behavioral pediatrics.* 2018;39(7):547-554. doi:10.1097/DBP.0000000000000586

12. Kingston D, Kehler H, Austin MP, et al. Trajectories of maternal depressive symptoms during pregnancy and the first 12 months postpartum and child externalizing and internalizing behavior at three years. *PLoS ONE.* 2018;13(4):1-20. doi:10.1371/journal.pone.0195365

13. Bufferd SJ, Dougherty LR, Carlson GA, Klein DN. Parent-reported mental health in preschoolers: findings using a diagnostic interview. *Compr Psychiatry.* 2011;52(4):359-369. doi:10.1016/j.comppsych.2010.08.006

14. Lu W. Child and adolescent mental disorders and health care disparities: Results from the national survey of children's health, 2011–2012. *J Health Care Poor Underserved.* 2017;28(3):988-1011. doi:10.1353/hpu.2017.0092

15. Egger HL, Angold A. Common emotional and behavioral disorders in preschool children: presentation, nosology, and epidemiology. *J Child Psychol Psychiatry.* 2006;47(3-4):313-337. doi:10.1111/j.1469-7610.2006.01618.x

16. Bor W, Dean AJ, Najman J, Hayatbakhsh R. Are child and adolescent mental health problems increasing in the 21st century? A systematic review. *Aust N Z J Psychiatry.* 2014;48(7):606-616. doi:10.1177/0004867414533834

17. Mesman J, Koot HM. Early preschool predictors of preadolescent internalizing and externalizing DSM-IV diagnoses. *J Am Acad Child Adolesc Psychiatry.* 2001;40(9):1029-1036. doi:10.1097/00004583-200109000-00011

18. Nagin D, Tremblay RE. Trajectories of Boys' Physical Aggression, Opposition, and Hyperactivity on the Path to Physically Violent and Nonviolent Juvenile Delinquency. *Child Dev.* 1999;70(5):1181-1196. doi:10.1111/1467-8624.00086

19. Jokela M, Ferrie J, Kivimaki M. Childhood Problem Behaviors and Death by Midlife: The British National Child Development Study. *J Am Acad Child Adolesc Psychiatry.* 2009;48(1):19-24. doi:10.1097/CHI.0b013e31818b1c76

20. Duchesne S, Vitaro F, Larose S, Tremblay RE. Trajectories of Anxiety During Elementary-school Years and the Prediction of High School Noncompletion. *J Youth Adolesc.* 2008;37(9):1134-1146. doi:https://doi.org/10.1007/s10964-007-9224-0

21. Leventhal T, Brooks-Gunn J. The neighborhoods they live in: The effects of neighborhood residence on child and adolescent outcomes. *Psychol Bull.* 2000;126(2):309-337. doi:10.1037/0033-2909.126.2.309

22. WHO. Social determinants of health. https://www.who.int/health-topics/social-determinants-of-health#tab=tab_1. Accessed October 5, 2021.

23. Subramanian SV, Kawachi I. Income inequality and health: What have we learned so far? *Epidemiol Rev.* 2004;26:78-91. doi:10.1093/epirev/mxh003

24. Kondo N, Sembajwe G, Kawachi I, Van Dam RM, Subramanian SV, Yamagata Z. Income inequality, mortality, and self rated health: meta-analysis of multilevel studies. *BMJ.* 2009;339(7731):1178-1181. doi:10.1136/bmj.b4471

25. Patel V, Burns JK, Dhingra M, Tarver L, Kohrt BA, Lund C. Income inequality and depression: a systematic review and meta-analysis of the association and a scoping review of mechanisms. *World Psychiatry.* 2018;17(1):76-89. doi:10.1002/wps.20492

26. Ribeiro WS, Bauer A, Knapp M, et al. Income inequality and mental illness-related morbidity and resilience: a systematic review and meta-analysis. *The Lancet Psychiatry.* 2017;4(7):554-562. doi:10.1016/S2215-0366(17)30159-1

27. Pabayo R, Cook DM, Harling G, Gunawan A, Rosenquist N, A., Muennig P. State-level income inequality and mortality among infants born in the United States 2007–2010: A Cohort Study. *BMC Public Health.* 2019;19(1):1-9. doi:10.1186/s12889-019-7651-y

28. Eckenrode J, Smith EG, McCarthy ME, Dineen M. Income Inequality and Child Maltreatment in the United States. *Pediatrics.* 2014;133(3):454-461. doi:10.1542/peds.2013-1707

29. Pickett KE, Wilkinson RG. Child Wellbeing and Income Inequality in Rich Societies: Ecological Cross Sectional Study. *BMJ.* 2007;335(7629):1080-1085. doi:10.1136/bmj.39377.580162.55

30. Wilkinson RG. Socioeconomic Determinants of Health: Health Inequalities: Relative or Absolute Material Standards? *BMJ.* 1997;314(7080):591-595. doi:10.1136/bmj.314.7080.591

31. Kahn RS, Wise PH, Kennedy BP, Kawachi I. State Income Inequality, Household Income, And Maternal Mental And Physical Health: Cross Sectional National Survey. *BMJ.* 2000;321(7272):1311-1315. doi:10.1136/bmj.321.7272.1311

32. Goodman SH, Rouse MH, Connell AM, Broth MR, Hall CM, Heyward D. Maternal Depression and Child Psychopathology: A Meta-Analytic Review. *Clin Child Fam Psychol Rev.* 2011;14(1):1. doi:10.1007/s10567-010-0080-1

33. Elliot J, Prior M, Merrigan C, Ballinger K. Evaluation of a community intervention programme for preschool behaviour problems. *J Paediatr Child Health.* 2002;38(1):41-50. doi:10.1046/j.1440-1754.2002.00713.x

34. Bronfenbrenner U. *The ecology of human development: experiments by nature and design.* Harvard University Press; 1979.

35. Bronfenbrenner U, Morris PA. The Bioecological Model of Human Development. In: Damon W, Lerner RM, eds. *Handbook of Child Psychology.* Sixth ed.: John Wiley & Sons 2007.

36. Shelton LG. *The Bronfenbrenner primer: a guide to develecology.* Routledge, Taylor & Francis Group; 2019.

37. Parkes A, Sweeting H, Wight D. Early Childhood Precursors and School age Correlates of Different Internalising Problem Trajectories Among Young Children. *J Abnorm Child Psychol.* 2016;44(7):1333. doi:10.1007/s10802-015-0116-6

38. Tremblay RE, Nagin DS, Séguin JR, et al. Physical aggression during early childhood: trajectories and predictors. *Pediatrics.* 2004;114(1):e43-50. doi:10.1542/peds.114.1.e43

39. Carneiro A, Dias P, Soares I. Risk Factors for Internalizing and Externalizing Problems in the Preschool Years: Systematic Literature Review Based on the Child Behavior Checklist 1½–5. *J Child Fam Stud.* 2016;25(10):2941. doi:10.1007/s10826-016-0456-z

40. Brooks-Gunn J, Duncan GJ. The Effects of Poverty on Children. *The Future of Children.* 1997;7(2):55-71. doi:10.2307/1602387

41. Comeau J, Boyle MH. Patterns of poverty exposure and children's trajectories of externalizing and internalizing behaviors. *SSM Popul Health.* 2018;4:86-94. doi:10.1016/j.ssmph.2017.11.012

42. Romano E, Tremblay RE, Farhat A, Cote S. Development and prediction of hyperactive symptoms from 2 to 7 years in a population-based sample. *Pediatrics.* 2006;117(6):2101-2110. doi:10.1542/peds.2005-0651

43. Rijlaarsdam J, Stevens GWJM, Van Der Ende J, et al. Economic Disadvantage and Young Children's Emotional and Behavioral Problems: Mechanisms of Risk. *J Abnorm Child Psychol.* 2013;41(1):125-137. doi:10.1007/s10802-012-9655-2

44. Hetherington E, McDonald S, Racine N, Tough S. Risk and Protective Factors for Externalizing Behavior at 3 Years: Results from the All Our Families Pregnancy Cohort. *J Dev Behav Pediatr.* 2018;39(7):547-554. doi:10.1097/DBP.0000000000000586

45. McDonald SW, Tough SC, Kehler HL. Risk factors for delayed social-emotional development and behavior problems at age two: Results from the All Our Babies/Families (AOB/F) cohort. *Health Science Reports.* 2018;1(10). doi:10.1002/hsr2.82

46. McDonald SW, Tough S, Madigan S, Racine N, Tomfohr L, Benzies K. Maternal adverse childhood experiences, mental health, and child behaviour at age 3: The all our families community cohort study. *Prev Med.* 2019;118:286-294. doi:10.1016/j.ypmed.2018.11.013

47. Letourneau N, Leung B, Ntanda H, Dewey D, Deane AJ, Giesbrecht GF. Maternal and paternal perinatal depressive symptoms associate with 2- and 3-year-old children's behaviour: findings from the APrON longitudinal study. *BMC Pediatr.* 2019;19(1):1-13. doi:10.1186/s12887-019-1775-1

48. Cote SM, Boivin M, Xuecheng LIU, Nagin DS, Zoccolillo M, Tremblay RE. Depression and anxiety symptoms: onset, developmental course and risk factors during early childhood. *J Child Psychol Psychiatry.* 2009;50(10):1201-1208. doi:10.1111/j.1469-7610.2009.02099.x

49. Weeks M, Naicker K, Colman I, Cairney J, Wild TC, Ploubidis GB. Early-life predictors of internalizing symptom trajectories in Canadian children. *Depress Anxiety.* 2014;31(7):608-616. doi:10.1002/da.22235

50. Shelleby EC, Votruba-Drzal E, Shaw DS, Dishion TJ, Wilson MN, Gardner F. Income and children's behavioral functioning: A sequential mediation analysis. *J Fam Psychol.* 2014;28(6):936-946. doi:10.1037/fam0000035

51. Xue Y, Leventhal T, Brooks-Gunn J, Earls FJ. Neighborhood residence and mental health problems of 5- to 11-year-olds. *Arch Gen Psychiatry.* 2005;62(5):554-563. doi:10.1001/archpsyc.62.5.554

52. Schneiders J, Drukker M, van der Ende J, Verhulst FC, van Os J, Nicolson NA. Neighbourhood Socioeconomic Disadvantage and Behavioural Problems from Late Childhood into Early Adolescence. *J Epidemiol Community Health.* 2003;57(9):699-703. doi:10.1136/jech.57.9.699

53. Boyle MH, Lipman EL. Do places matter? Socioeconomic disadvantage and behavioral problems of children in Canada. *J Consult Clin Psychol.* 2002;70(2):378-389. doi:10.1037//0022-006x.70.2.378

54. Sellström E, Bremberg S. Review Article: The significance of neighbourhood context to child and adolescent health and well-being: A systematic review of multilevel studies. *Scand J Public Health.* 2006;34(5):544-554. doi:10.1080/14034940600551251

55. Kalff AC, Kroes M, Vles JSH, et al. Neighbourhood Level and Individual Level SES Effects on Child Problem Behaviour: A Multilevel Analysis. *J Epidemiol Community Health.* 2001;55(4):246-250. doi:10.1136/jech.55.4.246

56. Kohen DE, Brooks-Gunn J, Leventhal T, Hertzman C. Neighborhood Income and Physical and Social Disorder in Canada: Associations with Young Children's Competencies. *Child Dev.* 2002;73(6):1844-1860. doi:10.1111/1467-8624.t01-1-00510

57. Stanley D. What Do We Know about Social Cohesion: The Research Perspective of the Federal Government's Social Cohesion Research Network. *Canad J Sociol.* 2003;28(1):5-17. doi:10.2307/3341872

58. Kawachi I. Social capital and health. In: Bird C, E., Conrad P, Fremont A, M., Timmermans S, eds. *Handbook of medical sociology.* Sixth ed.: Vanderbilt University Press; 2010:18-32.

59. Kingsbury M, McMartin SE, Weeks M, Colman I, Kirkbride JB, Wickham ME. Trajectories of childhood neighbourhood cohesion and adolescent mental health: Evidence from a national Canadian cohort. *Psychol Med.* 2015;45(15):3239-3248. doi:10.1017/S0033291715001245

60. Flouri E, Midouhas E, Joshi H, Sullivan A. Neighbourhood social fragmentation and the mental health of children in poverty. *Health Place.* 2015;31:138-145. doi:10.1016/j.healthplace.2014.11.009

61. Berkman LF, Kawachi I, Glymour M, Maria. *Social epidemiology.* Second ed: Oxford University Press; 2014.

62. Kennedy BP, Kawachi I, Prothrow-Stith D. Income distribution and mortality: cross sectional ecological study of the Robin Hood index in the United States. *BMJ.* 1996;312(7037):1004-1007. doi:10.1136/bmj.312.7037.1004

63. De Maio FG. Income inequality measures. *J Epidemiol Community Health.* 2007;61(10):849-852. doi:10.1136/jech.2006.052969

64. Milligan K. Income Inequality and Income Taxation in Canada: Trends in the Census 1980-2005. *The School of Public Policy Publications.* 2013;6(24):1-29. doi:10.11575/sppp.v6i0.42436

65. Canada S. Table 11-10-0134-01 Gini coefficients of adjusted market, total and after-tax income. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110013401. Published 2021. Accessed October 5, 2021.

66. Kondo N, van Dam RM, Sembajwe G, Subramanian SV, Kawachi I, Yamagata Z. Income inequality and health: the role of population size, inequality threshold, period effects and lag effects. *J Epidemiol Community Health.* 2012;66(6). doi:10.1136/jech-2011-200321

67. CensusMapper. After Tax Income Gini Coefficient. https://censusmapper.ca/maps/682#11/51.0531/-114.0626. Published 2017. Accessed October 5, 2021.

68. Chen W-H, Myles J, Picot G. Why Have Poorer Neighbourhoods Stagnated Economically while the Richer Have Flourished? Neighbourhood Income Inequality in Canadian Cities. *Urban Studies.* 2012;49(4):877-896. doi:10.1177/0042098011408142

69. Wilkinson RG, Pickett KE. The problems of relative deprivation: Why some societies do better than others. *Soc Sci Med.* 2007;65(9):1965-1978. doi:10.1016/j.socscimed.2007.05.041

70. Kawachi I, Kennedy BP. Income inequality and health: pathways and mechanisms. *Health Serv Res.* 1999;34(1 Pt 2):215-227. https://pubmed.ncbi.nlm.nih.gov/10199670.

71. Lynch JW, Smith GD, Kaplan GA, House JS. Income Inequality and Mortality: Importance to Health of Individual Income, Psychosocial Environment, or Material Conditions. *BMJ.* 2000;320(7243):1200-1204. doi:10.1136/bmj.320.7243.1200

72. Buttrick NR, Oishi S. The psychological consequences of income inequality. *Soc Personal Psychol Compass.* 2017;11(3). doi:10.1111/spc3.12304

73. Wilkinson RG, Pickett KE. Income inequality and population health: A review and explanation of the evidence. *Soc Sci Med.* 2006;62(7):1768-1784. doi:10.1016/j.socscimed.2005.08.036

74. Sapolsky RM. The Influence of Social Hierarchy on Primate Health. *Science.* 2005;308(5722):648-652. doi:10.1126/science.1106477

75. Layte R. The Association Between Income Inequality and Mental Health: Testing Status Anxiety, Social Capital, and Neo-Materialist Explanations. *European Sociological Review.* 2012;28(4):498-511. doi:10.1093/esr/jcr012

76. Harling G, Subramanian SV, Barnighausena T, Kawachi I. Income inequality and sexually transmitted in the United States: Who bears the burden? *Soc Sci Med.* 2014;102:174-182. doi:10.1016/j.socscimed.2013.11.025

77. Dev S, Kim D. State-Level Income Inequality and County-Level Social Capital in Relation to Individual-Level Depression in Middle-Aged Adults: A Lagged Multilevel Study. *Int J Environ Res Public Health.* 2020;17(15):5386. doi:10.3390/ijerph17155386

78. Lynch JW, Kaplan GA. Understanding how inequality in the distribution of income affects health. *J Health Psychol.* 1997;2(3):297-314. doi:10.1177/135910539700200303

79. Kaplan GA, Pamuk ER, Lynch JW, Cohen RD, Balfour JL. Inequality In Income And Mortality In The United States: Analysis Of Mortality And Potential Pathways. *BMJ.* 1996;312(7037):999-1003. doi:10.1136/bmj.312.7037.999

80. Fone D, Greene G, Farewell D, White J, Kelly M, Dunstan F. Common mental disorders, neighbourhood income inequality and income deprivation: small-area multilevel analysis. *Br J Psychiatry.* 2013;202(AVR):286-293. doi:10.1192/bjp.bp.112.116178

81. Elgar FJ, Dirks M, Gariepy G, et al. Association of Early-Life Exposure to Income Inequality with Bullying in Adolescence in 40 Countries. *JAMA Pediatrics.* 2019;173(7). doi:10.1001/jamapediatrics.2019.1181

82. Elgar FJ, Gariépy G, Torsheim T, Currie C. Early-life income inequality and adolescent health and well-being. *Soc Sci Med.* 2017;174:197-208. doi:10.1016/j.socscimed.2016.10.014

83. Pabayo R, Kawachi I, Gilman SE. Income inequality among American states and the incidence of major depression. *J Epidemiol Community Health.* 2014;68(2):110-115. doi:10.1136/jech-2013-203093

84. Windham AM, Rosenberg L, Fuddy L, McFarlane E, Sia C, Duggan AK. Risk of mother-reported child abuse in the first 3 years of life. *Child Abuse Negl.* 2004;28(6):645-667. doi:10.1016/j.chiabu.2004.01.003

85. Pabayo R, Dunn EC, Gilman SE, Kawachi I, Molnar BE. Income inequality within urban settings and depressive symptoms among adolescents. *J Epidemiol Community Health.* 2016;70(10):997-1003. doi:10.1136/jech-2015-206613

86. McLaughlin KA, Costello EJ, Leblanc W, Sampson NA, Kessler RC. Socioeconomic Status and Adolescent Mental Disorders. *Am J Public Health.* 2012;102(9):1742-1750. doi:10.2105/AJPH.2011.300477

87. Goodman E, Bin H, Wade TJ, Kahn RS. A multilevel analysis of the relation of socioeconomic status to adolescent depressive symptoms: Does school context matter? *J Pediatr.* 2003;143(4):451-456. doi:10.1067/S0022-3476(03)00456-6

88. Rivenbark JG, Copeland WE, Davisson EK, et al. Perceived Social Status and Mental Health among Young Adolescents: Evidence from Census Data to Cellphones. *Dev Psychol.* 2019;55(3):574-585. doi:10.1037/dev0000551

89. Vilhjalmsdottir A, Bernburg JG, Gardarsdottir RB, Sigfusdottir ID. Community income inequality and adolescent emotional problems: A population-based study. *J Community Psychol.* 2018;46(6):715-733. doi:10.1002/jcop.21968

90. Vilhjalmsdottir A, De Clercq B, Gardarsdottir RB, Bernburg JG, Sigfusdottir ID. Decreasing income inequality and adolescent emotional distress: a population-based case study of Icelandic adolescents 2006–2016. *Int J Public Health.* 2019;64(2):253. doi:10.1007/s00038-018-1193-4

91. Vilhjalmsdottir A, Gardarsdottir RB, Bernburg JG, Sigfusdottir ID. Neighborhood income inequality, social capital and emotional distress among adolescents: A population-based study. *J Adolesc.* 2016;51:92-102. doi:10.1016/j.adolescence.2016.06.004

92. Quon EC, McGrath JJ. Province-Level Income Inequality and Health Outcomes in Canadian Adolescents. *J Pediatr Psychol.* 2014;40(2):251-261. doi:10.1093/jpepsy/jsu089

93. Quon EC, McGrath JJ. Community, family, and subjective socioeconomic status: Relative status and adolescent health. *Health Psychol.* 2015;34(6):591-601. doi:10.1037/hea0000135

94. Kim Y, Hagquist C. Mental health problems among economically disadvantaged adolescents in an increasingly unequal society: A Swedish study using repeated cross-sectional data from 1995 to 2011. *SSM Popul Health.* 2018;6(44-53):44-53. doi:10.1016/j.ssmph.2018.08.006

95. Elgar FJ, Pförtner TK, Moor I, De Clercq B, Stevens GWJM, Currie C. Socioeconomic inequalities in adolescent health 2002-2010: A time-series analysis of 34 countries participating in the Health Behaviour in School-aged Children study. *The Lancet.* 2015;385(9982):2088-2095. doi:10.1016/S0140-6736(14)61460-4

96. Dierckens M, Huang Y, Deforche B, et al. National-Level Wealth Inequality and Socioeconomic Inequality in Adolescent Mental Well-Being: A Time Series Analysis of 17 Countries. *J Adolesc Health.* 2020;66(6):S21-S28. doi:10.1016/j.jadohealth.2020.03.009

97. Goldstein RB, Lee AK, Haynie DL, et al. Neighbourhood disadvantage and depressive symptoms among adolescents followed into emerging adulthood. *J Epidemiol Community Health.* 2019;73(7):590-597. doi:10.1136/jech-2018-212004

98. Pu C, Huang N, Chou YJ. Do agreements between adolescent and parent reports on family socioeconomic status vary with household financial stress? *BMC Med Res Methodol.* 2011;11. doi:10.1186/1471-2288-11-50

99. Hosmer DW, Lemeshow S, Sturdivant RX. *Applied logistic regression.* Third ed: Wiley; 2013.

100. Elgar FJ, Craig W, Boyce W, Morgan A, Vella-Zarb R. Income Inequality and School Bullying: Multilevel Study of Adolescents in 37 Countries. *J Adolesc Health.* 2009;45(4):351-359. doi:10.1016/j.jadohealth.2009.04.004

101. Pabayo R, Kawachi I, Molnar BE. The role of neighborhood income inequality in adolescent aggression and violence *J Adolesc Health.* 2014;55(4):571-579. doi:10.1016/j.jadohealth.2014.04.012

102. Tough SC, McDonald SW, Collisson BA, et al. Cohort Profile: The All Our Babies pregnancy cohort (AOB). *Int J Epidemiol.* 2017;46(5):13. doi:10.1093/ije/dyw363

103. McDonald SW, Lyon AW, Benzies KM, et al. The All Our Babies pregnancy cohort: design, methods, and participant characteristics. *BMC Pregnancy Childbirth.* 2013;13. doi:10.1186/1471-2393-13-S1-S2

104. Canada S. Dissemination area: Detailed definition. https://www150.statcan.gc.ca/n1/pub/92-195-x/2011001/geo/da-ad/def-eng.htm. Published 2018. Accessed October 5, 2021.

105. Canada S. Persons living in low-income neighbourhoods: national household survey (NHS). https://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-014-x/99-014-x2011003_3-eng.pdf. Published 2013. Accessed.

106. Schafer JL. Multiple imputation: a primer. *Stat Methods Med Res.* 1999;8(1):3-15. doi:10.1177/096228029900800102

107. von Hippel PT, Hunter DJ, Drown M. Better Estimates from Binned Income Data: Interpolated CDFs and Mean-Matching. *Sociol Sci.* 2017;4(26):641-655. doi:10.15195/v4.a26

108. *Generate PDFs and CDFs from binned data* [computer program]. Version 0.2.22020.

109. Achenbach TM, Edelbrock C, Howell CT. Empirically based assessment of the behavioral/emotional problems of 2- and 3- year-old children. *J Abnorm Child Psychol.* 1987;15(4):629-650. doi:10.1007/BF00917246

110. Celentano DD, Szklo M, Gordis L. *Gordis epidemiology.* Sixth edition. ed: Elsevier; 2019.

111. Charach A, Lin E, To T. Evaluating the Hyperactivity/Inattention Subscale of the National Longitudinal Survey of Children and Youth. *Health Rep.* 2010;21(2):45-52. https://www150.statcan.gc.ca/n1/pub/82-003-x/2010002/article/11234-eng.pdf.

112. Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika.* 1951;16(3):297. doi:10.1007/bf02310555

113. Bland JM, Altman DG. Cronbach's alpha. *BMJ.* 1997;314(7080). doi:https://doi.org/10.1136/bmj.314.7080.572

114. Kingston D, Kehler H, Mughal MK, et al. Trajectories of maternal depressive symptoms during pregnancy and the first 12 months postpartum and child externalizing and internalizing behavior at three years. *PLoS One.* 2018;13(4). doi:10.1371/journal.pone.0195365

115. Canada S. Low income definitions. https://www150.statcan.gc.ca/n1/pub/75f0011x/2012001/notes/low-faible-eng.htm. Published 2015. Accessed October 5, 2021.

116. Raudenbush SW, Bryk AS. *Hierarchical linear models: applications and data analysis methods.* 2nd ed: Sage Publications; 2002.

117. *Stata Statistical Software: Release 15* [computer program]. College Station, TX: StataCorp, LLC; 2017.

118. Mäntymaa M, Puura K, Luoma I, Latva R, Salmelin RK, Tamminen T. Predicting Internalizing and Externalizing Problems at Five Years by Child and Parental Factors in Infancy and Toddlerhood. *Child Psychiatry Hum Dev.* 2012;43(2):153-170. doi:10.1007/s10578-011-0255-0

119. Hser Y-I, Lanza HI, Li L, Kahn E, Evans E, Schulte M. Maternal Mental Health and Children's Internalizing and Externalizing Behaviors: Beyond Maternal Substance Use Disorders. *Journal of Child and Family Studies.* 2015;24(3):638. doi:10.1007/s10826-013-9874-3

120. Yan N, Liu Y, Ansari A, Li K, Li X. Mothers' Depressive Symptoms and Children's Internalizing and Externalizing Behaviors: Examining Reciprocal Trait-State Effects from Age 2 to 15. *Child Dev.* 2021. doi:10.1111/cdev.13609

121. Hui Z. Do people die from income inequality of a decade ago? *Soc Sci Med.* 2012;75(1):36-45. doi:10.1016/j.socscimed.2012.02.042

122. Berkman LF, Kawachi I, Glymour MM. *Social epidemiology.* Second edition. ed: Oxford University Press; 2014.

123. Slaunwhite AK. The Role of Gender and Income in Predicting Barriers to Mental Health Care in Canada. *Community Mental Health Journal.* 2015;51(5):621-627. doi:10.1007/s10597-014-9814-8

124. Wilkinson RG, Pickett K. *The spirit level: why equality is better for everyone.* Penguin; 2010.

125. Mikkonen J, Raphael D. *Social determinants of health: the Canadian facts.* York University, School of Health Policy and Management; 2010.

126. Kroes G, Veerman JW, De Bruyn EEJ. Bias in Parental Reports?: Maternal Psychopathology and the Reporting of Problem Behavior in Clinic-Referred Children. *Eur J Psychol Assess.* 2003;19(3):195-203. doi:https://doi.org/10.1027/1015-5759.19.3.195

127. Kline RB. *Principles and practice of structural equation modeling.* Fourth ed: The Guilford Press; 2016.

128. Mobley LR, Kuo T-M, Andrews L. How Sensitive Are Multilevel Regression Findings to Defined Area of Context?: A Case Study of Mammography Use in California. *Med Care Res Rev.* 2007;65(3):315-337. doi:10.1177/1077558707312501

129. Takagi D, Ikeda K, Kawachi I. Neighborhood social capital and crime victimization: Comparison of spatial regression analysis and hierarchical regression analysis. *Soc Sci Med.* 2012;75(10):1895-1902. doi:10.1016/j.socscimed.2012.07.039

Appendix A

Prevalence of preschooler's emotional and behavioural problems

In Canada, the prevalence of mental health problems in the general population of pre-school-aged children is not well documented. To better understand the public health burden, the prevalence of emotional and behaviour problems across several studies and populations are presented in table 1a below. Given the range of study locations, tools, and dimension of mental health measured, cross-study comparison is challenging. Regardless, the table still provides; author, location, child age, measurement tool, reported prevalence, and study reliability and validity of the measure where available. Overall, the prevalence of emotional and behavioural problems across 7 studies ranged from 0.3-25%.[8-14]

Table 1a Studies examining reporting the prevalence of preschooler's emotional and behavioural problems

Author	Location and age	Measure	Prevalence	Reliability & validity
Buffered et al 2011[13]	USA Age: 3	PAPA version 1.4	Any emotional disorder: 20.3% (95%CI: 16.9-23.7) Depression: 1.5% (95%CI: 0.5-2.5) Oppositional defiant disorder: 9.4% (95% CI: 6.9-11.9) Separation anxiety: 5.4% (95%CI: 3.5-.3) Any anxiety disorder: 19.6% (95%CI: 16.3-22.9)	N/A
Dome `nech-Llaberia et al 2009[9]	Spain Age: 3-6	ESDM 3-6	Any disorder: 15% (95%CI: 13.7-17.6) Major depressive disorder: 1.12% (95%CI: 0.66-1.86)	
Hetherington et al 2018[44]	Canada Age: 3	NLSCY-CBCL	Externalizing problems: 23.7%.	Cronbach alpha: 0.76
Lu 2017[14]	USA Age 2-5	Not specified	Depression: 0.3% Anxiety problems: 0.8% Conduct problems: 1.5%	N/A
Kingston et al 2018[114]	Canada Age: 3	NLSCY-CBCL	-Separation anxiety: 18.9% -Physical Aggression: 13.0% -Hyperactivity: 18.9% -Emotional/anxiety: 9.7%	Cronbach alpha: 0.59-0.80
Wlodarczyk 2015[8]	Germany Age: 3-4	CBCL 1.5/5	Anxiety/depression: 4.1% Physical aggression: 0.8%	Cronbach alpha: Anxiety: 0.69 Aggression: 0.87

Appendix B

Table 2a Methods used in literature synopsis on income inequality and emotional and behavioural problems in children and adolescents.

Exposure search terms	Outcome search terms	Population	Databases	Dates accessed	Inclusion criteria
Income inequality and emotional disorders in children and adolescents					
Inequalities, income inequality, income inequalit*, Gini coefficient, income distribution	Anxiety, depression, depressive symptoms, emotional distress, mental health problems, anxiety symptoms, affect disorder, internalizing problems, emotional problems	Child, adolescent, toddler, preschooler	PsycINFO, Web of Science, PubMed, and Medline: via Embase and Ovid Medline(R) Peer-review articles from 1946 to August 10th, 2021, were included	Search commenced October 2019, and concluded August 10th, 2021	**Inclusion criteria:** Articles with relevant population of interest, outcome, and measure of income inequality as defined by search terms. Income inequality measures could include decile ratios (50/50, 10/90, 20/80), Gini coefficient, coefficient of variation, Thiel index, and Atkinson index. **Exclusion criteria:** Not using income inequality measure, adult population, using measure of income inequality, but nonrelevant outcome.
Income inequality and behavioural disorders in children and adolescents					
Inequalities, income inequality, income inequalit*, Gini coefficient, income distribution	Physical aggression, conduct disorder, externalizing problems, hyperactivity or inattention, oppositional defiant disorder, behaviour problems	Child, adolescent, toddler, preschooler	PsycINFO, Web of Science, PubMed, and Medline: via Embase and Ovid Medline(R) Peer-review articles from 1946 to August 10th, 2021, were included	Search commenced May 25th, 2020, and concluded August 10th, 2021	**Inclusion criteria:** Articles with relevant population of interest, outcome, and measure of income inequality as defined by search terms. fighting, and bullying perpetration. **Exclusion criteria:** Not using income inequality measure, adult population, using measure of income inequality, but nonrelevant outcome such as studies only examining children as victims of violence or bullying.

Appendix C

Table 3a Mother completed questionnaire NLSCY-CBCL used to measure internalizing and externalizing problems in children

Subscale	Questions	Cronbach's Alpha
Physical Aggression	(1) Is defiant. (2) Gets into many fights. (3) Punishment doesn't change his/her behaviour. (4) Has temper tantrums or hot temper. (5) Has difficulty awaiting turn in games or groups. (6) When somebody accidentally hurts him/her, he/she reacts with anger and fighting. (7) Has angry moods. (8) Kicks, bites, hits other children.	**0.74**
Hyperactivity/ Inattention	(1) Can't sit still or is restless (2) Is distractible, has trouble sticking to any activity (3) Can't concentrate, can't pay attention for long (4) Is impulsive, acts without thinking (5) Is inattentive (6) Cannot settle to anything for more than a few minutes.	**0.80**
Emotional/anxiety	(1) Seems to be unhappy, sad, or depressed (2) Is not as happy as other children (3) Is fearful of nervous (4) Is worried (5) Is nervous, high-strung, or tense (6) Has trouble enjoying him/herself.	**0.60**
Separation anxiety	(1) Cries a lot (2) Clings to adults or is too dependent (3) Constantly seeks help (4) Doesn't want to sleep alone (5) Gets too upset when separated from parents.	**0.58**

Note: Information on scale construction can be found elsewhere.[5]

Appendix D

Figure 1a Ethics approval certificate

Notification of Approval (Renewal)

Date:	May 19, 2021
Amendment ID:	Pro00083081_REN3
Principal Investigator:	Roman Pabayo
Study ID:	MS4_Pro00083081
Study Title:	Neighborhood income inequality and maternal and child mental health in Calgary
Sponsor/Funding Agency:	CIHR - Canadian Institutes for Health Research CIHR MSI Foundation MSI

	Project ID	Title	Grant Status	Sponsor	Project Start Date	Project End Date	Purpose	Other Information
RSO-Managed Funding:	RES0040557							
	RES0040064RA							

Approval Expiry Date:	May 18, 2022

Thank you for submitting this renewal application. Your application has been reviewed and approved.

Approved Documents:

This re-approval is valid for one year. If your study continues past the expiration date as noted above, you will be required to complete another renewal request. Beginning at 30 days prior to the expiration date, you will receive notices that the study is about to expire. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Sincerely,

Kimberley Kordov, REB Specialist, on behalf of

Ubaka Ogbogu, LLB, BL, LLM, SJD
Chair, Research Ethics Board 2

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Appendix E

Figure 2a Overall predicted probability and plausible value range

| **Overall predicted probability:** | | $1 \, / \, 1 + e^{-\gamma 00}$ |

Where   e = exponential
$\gamma 00$ = Coefficient of the intercept

Plausible value range: Lower bound: $1 \, / \, 1 + e^{\,-[\gamma 00 \, - \, 1.96\sqrt{\,}\tau 00]}$
Upper bound: $1 \, / \, 1 + e^{\,-[\gamma 00 \, + \, 1.96\sqrt{\,}\tau 00]}$

Where   e = exponential
$\gamma 00$ = Coefficient of the intercept
$\tau 00$ = residual area-level variation

Note: Figure adapted from Raudenbush & Bryk,[116] by R. Pabayo, PhD, written document, 2015.

Appendix F

This table is a comparison of all neighbourhood-level variables included in the analysis section above.

Table 4a Polychoric correlations among all variables of interest in AOF cohort (n=1,595)

Study variables	1	2	3	4	5
1.Income inequality	-				
2.LICO	0.4583	-			
3.Visibleminority	-0.2365	0.0513	-		
4.Over $100,000 CAD	-0.2149	-0.6264	-0.0030	-	
5.Recent immigrant	-0.1337	0.2370	0.6926	-0.2251	-

Appendix G

The results of the statistical analysis are shown in <u>table 5</u> and <u>table 6</u>. Univariate models (model 1, 4, 7, 10) demonstrate a non-statistically significant relationship between neighbourhood income inequality and either any of emotional/ anxiety, hyperactivity/inattention, physical aggression, and separation anxiety problems at 3-years of age.

This insignificant relationship remained when individual-level confounders was added to the model for physical aggression (OR = 0.96 95% CI: 0.81, 1.15), hyperactivity/inattention (OR = 1.04, 95% CI: 0.90, 1.21), emotional/ anxiety (OR = 0.93 95% CI: 0.78, 1.12) and separation anxiety (OR = 0.95 95% CI: 0.81, 1.11). When neighbourhood-level confounders were added to the models, physical aggression (OR = 1.01, 95% CI: 0.83, 1.24), hyperactivity/inattention (OR = 1.04, 95% CI: 0.87, 1.24), emotional/ anxiety (OR = 0.97, 95% CI: 0.78, 1.21) and separation anxiety (OR = 0.95, 95% CI: 0.79, 1.14). When neighbourhood-level confounders were added to the models' problems remained insignificant.

In fully adjusted models (table 5; model 6), lower household income (below $80,000 CAD) was associated with a 50% increase in odds (OR=1.50, 95% CI: 1.08, 2.10) of being "at-risk" for hyperactivity/inattention symptoms in 3-year-olds. Unsurprisingly, if children were living with single mothers compared to coupled, preschoolers were at 86% increased odds (OR = 1.86, 95% CI: 1.10, 3.16) for "at-risk" separation anxiety symptoms (table 6; model 12), controlling for individual and neighbourhood-level confounders.

As seen the results between those reported in the results section and the results in this sensitivity analysis are similar, with no change in the results for the main exposure (income inequality). Therefore, the more general spectrum disorders (internalizing and externalizing) and easily interpretable results were presented.

Table 5a Multilevel logistic models examining associations between neighbourhood income inequality and "at-risk" for physical aggression (n=1588) and hyperactivity/inattention (n=1598) in preschoolers across n=184 neighbourhoods

	Physical aggression						Hyperactivity/inattention					
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Neighbourhood Characteristics												
Income inequality (z-score)	0.98	0.82 ,1.16	0.96	0.81, 1.15	1.01	0.83, 1.24	1.04	0.90, 1.19	1.04	0.90, 1,21	1.04	0.87, 1.24
Proportion LICO (z-score)					0.89	0.89, 1.14					1.01	0.75, 1.36
Proportion visible minority (z-score)					1.16	0.90, 1.51					1.19	0.94, 1.50
Proportion recent immigrant (z-score)					0.97	0.74, 1.26					0.78	0.60, 0.98
Proportion >100k (z-score)					0.89	0.70, 1.14					0.96	0.78, 1.19
Individual Characteristics												
Household income (ref: greater than $79,999 CAD/year)												
Less than $79,999CAD			1.06	0.72, 1.56	1.02	0.69, 1.51			**1.53**	**1.11, 2.12**	**1.50**	**1.08, 2.10**
Education (ref: post-secondary)												
High school			1.35	0.93, 1.97	1.33	0.91, 1.94			0.98	0.69, 1.40	0.97	0.68, 1.39
Marital status (ref: coupled)												
Single			1.48	0.79, 2.77	1.47	0.79, 2.76			0.82	0.43, 1.54	0.82	0.43, 1.56
Mother's ethnicity (ref: white)												
Non-white			0.71	0.47, 1.08	0.67	0.43, 1.03			1.24	0.89, 1.72	1.23	0.87, 1.73
Sex of child (ref: female)												
Male			1.35	1.00, 1.81	1.34	0.99, 1,81			1.25	0.96, 1.64	1.26	0.97, 1.65

Note: **Bold** indicates a two-sided α≤0.05.

Table 6a Multilevel logistic models examining associations between neighbourhood income inequality and "at-risk" for separation anxiety (n=1588) and emotional/ anxiety problems (n=1598) in preschoolers across n=184 neighbourhoods

	Emotion/anxiety						Separation anxiety					
	Model 7		Model 8		Model 9		Model 10		Model 11		Model 12	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Neighbourhood Characteristics												
Income inequality (z-score)	0.94	0.79, 1.13	0.93	0.78, 1.12	0.97	0.78, 1.21	0.89	0.76, 1.05	0.95	0.81, 1.11	0.95	0.79, 1.14
Proportion LICO (z-score)					0.88	0.62, 1.26					1.07	0.83, 1.38
Proportion visible minority (z-score)					1.06	0.80, 1.39					1.13	0.90, 1,41
Proportion recent immigrant (z-score)					1.02	0.77, 1.34					0.99	0.78, 1.24
Proportion >100k (z-score)					0.90	0.70, 1.17					0.99	0.81, 1.22
Individual Characteristics												
Household income (ref: greater than $79,999 CAD/year)												
Less than $79,999CAD			1.44	0.96, 2.15	1.41	0.93, 2.12			**1.39**	**1.01, 1.90**	1.33	0.96, 1.83
Education (ref: post-secondary)												
High school			0.62	0.38, 1.03	0.62	0.38, 1.02			1.15	0.82, 1.61	1.13	0.81, 1.59
Marital status (ref: coupled)												
Single			0.81	0.36, 1.85	0.81	0.35, 1.85			**1.91**	**1.13, 3.23**	**1.86**	**1.10, 3.16**
Mother's ethnicity (ref: white)												
Non-white			1.33	0.90, 1.97	1.29	0.86, 1.94			**2.34**	**1.75, 3.14**	**2.22**	**1.64, 3.00**
Sex of child (ref: female)												
Male			0.89	0.78, 1.12	0.89	0.64, 1.24			0.99	0.76, 1.28	0.98	0.76, 1.27

Note: **Bold** indicates a two-sided α≤0.05.

Appendix H

A sensitivity analysis including child age at the time of survey was conducted. The literature on neighbourhood effects and child development remains unclear with specific variables to include. To ensure that age-specific effects were controlled for, child age was included in the model, measured by asking parents at the time of survey how old the child was in months. Results for the analysis can be found in table 7a below. The analysis depicts no changes in results from those reported in chapter 4 for income inequality or household income.

Table 7a Multilevel logistic models examining associations between neighbourhood income inequality and "at-risk" for internalizing or externalizing problems (n=1592) in preschoolers across n=184 neighbourhoods including child age

	Internalizing				Externalizing			
	Model 1		Model 2		Model 3		Model 4	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Neighbourhood Characteristics								
Income inequality (z-score)	0.97	0.84, 1.12	0.97	0.82, 1.14	1.01	0.88, 1.16	1.04	0.88, 1.22
Proportion LICO (z-score)			1.05	0.83, 1.33			0.94	0.73, 1.21
Proportion visible minority (z-score)			1.12	0.91, 1.38			1.23	0.99, 1.52
Proportion recent immigrant (z-score)			0.96	0.78, 1.19			0.80	0.64, 1.00
Proportion >100k (z-score)			0.97	0.80, 1.17			0.92	0.77, 1.12
Individual Characteristics								
Household income (ref: greater than $79,999 CAD/year)								
Less than $79,999CAD	**1.42**	**1.07, 1.91**	**1.37**	**1.02, 1.85**	**1.38**	**1.03, 1.85**	1.33	0.99, 1.81
Education (ref: post-secondary)								
High school	0.98	0.72, 1.35	0.97	0.70, 1.33	1.18	0.87, 1.60	1.16	0.86, 1.58
Marital status (ref: coupled)								
Single	1.54	0.70, 1.11	1.51	0.90, 2.52	0.95	0.55, 1.63	0.96	0.55, 1.65
Mother's ethnicity (ref: white)								
Non-white	**2.07**	**1.57, 2.74**	**1.98**	**1.49, 2.64**	1.01	0.75, 1.37	0.98	0.72, 1.34
Sex of child (ref: female)								
Male	0.88	0.70, 1.11	0.88	0.69, 1.11	**1.29**	**1.02, 1.62**	**1.29**	**1.02, 1.63**
Child age (in months)	0.97	0.92, 1.03	0.97	0.91, 1.03	1.01	0.95, 1.07	1.00	0.73, 1.21

Note: **Bold** indicates a two-sided α≤0.05.