INVESTIGATING THE ASSOCIATION BETWEEN INCOME INEQUALITY AND
MENTAL HEALTH AND DEATHS OF DESPAIR IN CANADIAN YOUTH

by

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ABSTRACT

Rationale: Over the past two decades, both income inequality and adverse mental health in youth have increased in Canada. Income inequality is defined as the gaps between highest earners and lowest earners within a given group or area. Some research indicates that income inequality is associated with worsened mental health. Alongside this, all-cause mortality has risen greatly, as with disability-adjusted life years, likely driven in part by marked increases in deaths attributed to suicide, drug overdose, and alcohol-related liver disease, collectively known as 'deaths of despair'. Given that adverse mental health is a risk factor for deaths of despair, it is possible that income inequality may drive increases in both mental health conditions, such as depression and anxiety, and risk for deaths of despair especially amongst young people. Previous studies have primarily been cross-sectional or ecological, and no previous research has examined the association between income inequality and deaths of despair, thus limiting our understanding of these potential associations. Furthermore, both income inequality and mental health conditions may be exacerbated during the COVID-19 pandemic, as such it is important to assess the association between income inequality and mental health in youth during COVID-19.

Objectives: The overarching goals of the thesis are to investigate the role of income inequality and mental health conditions, such as depression and anxiety, and risk for deaths of despair in Canadian youth. Four investigations informed this goal, testing the following hypotheses: 1) that income inequality is associated with depression and anxiety over time in school-aged sample of adolescents; 2) psychosocial well-being and social cohesion may mediate the relationship between income inequality and adolescent depression; 3) that the association between income inequality and adolescent depression and anxiety was amplified during COVID-19; and, 4) that

income inequality in youth is associated with an increased risk of deaths of despair, or those deaths owing to suicide, drug overdose, and alcohol-related liver disease, over time.

Methods: Two large cohorts of youth were sampled to address these objectives, including Cannabis, Obesity, Mental health, Physical activity, Alcohol, Smoking, and Sedentary behaviour (COMPASS), the Canadian Census Health and Environment Cohort Profile (CanCHEC) from 2006 and 2016. Latent growth curve modelling techniques were applied to address objectives 1 and 3, cross-sectional multilevel path analyses were applied for objective 2, and multilevel survival analyses were applied for objective 4.

Results: Analyses addressing the objectives of this thesis showed that, according to results from the linear mixed models employed in objective 1, CD-level income inequality was associated with an increase in z-transformed adolescent depressive scores (ß=0.08; 95% CI = 0.02, 0.14) and was not significantly associated with a change in z-transformed adolescent anxiety scores. Results from the multi-level path analysis employed to assess objective 2 indicated that students attending schools in CDs with higher income inequality reported higher depression scores among Canadian secondary students (β = 5.36; 95% CI = 0.74, 9.99) and lower psychosocial well-being (β = -14.83, 95% CI = -25.05, -4.60). For objective 3, adjusted, linear mixed models demonstrated that the association between income inequality and anxiety scores was significantly exacerbated following the onset of COVID-19 (β =0.02, 95% CI=0.0004, 0.03), indicating that income inequality was associated with a greater increase in anxiety scores during COVID-19, as compared to before COVID-19. Finally, the results of assessing objective 4 of this thesis showed that a SD-unit increase in Gini coefficient was associated with an increase in

the hazard ratio for deaths of despair [adjusted hazard ratio (aHR): 1.35; 95% CI: 1.04, 1.75], drug overdose (aHR: 2.38; 95% CI: 1.63, 3.48), and all-cause deaths (aHR: 1.10; 95% CI: 1.04, 1.18).

Conclusion: The findings from this thesis highlight associations between income inequality and adolescent depression and anxiety (particularly during COVID-19), and deaths of despair in youth. This work can inform programs and policies for reducing income inequality, improving youth mental health, and reducing the risk of deaths of despair amongst young Canadians, particularly during a public health crisis, such as a global pandemic.

PREFACE

Some of the research conducted for this thesis is part of a research collaboration, EMERGE Lab, led by Dr. Roman Pabayo at the University of Alberta. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board. Specifically, Chapters 2 through 4 of this thesis used data from COMPASS, as such, Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2) certification requirements were completed to access and disseminate the COMPASS data. The current study was approved by the University of Alberta IRB, the University of Waterloo Research Ethics Board (ORE 30118), Brock University (REB#18-099), CIUSSS de la Capitale-Nationale–Université Laval (#MP-13-2017-1264), and participating school boards. For the study outlined in Chapter 5, research ethics board approval for this study was obtained through the University of Alberta (Project ID: RES0052784). Documents providing evidence of ethical approval are available in Appendix A.

Chapter 3 (Article 1) of this thesis has been 'accepted' is in press at the *Journal of Adolescent Health*. The suggested citation for this work is: Benny C, Patte KA, Senthilselvan A, Veugelers PV, Leatherdale ST, Pabayo R. A longitudinal study of income inequality and mental health among Canadian secondary school students, results from the COMPASS Study (2016-2019). Accepted, in press. *Journal of Adolescent Health.* CB contributed to the conceptualization, formal analysis, methodology, and writing – original draft, and the revision. KAP contributed to, funding acquisition, project administration, investigation, and editing of the writing – original draft, and the revision. PJV contributed to the conceptualization, supervision, and editing of the writing – original draft. AS contributed to the editing of the original draft. STL contributed to

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Acknowledgements

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List of Abbreviations

CanCHEC - Canadian Census Health and Environment Cohorts

CD – Census division

CES-D - Center for Epidemiologic Studies Depression Scale

CFI - Comparative fit index

COMPASS - Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking, and Sedentary behaviour

CVSD – Canadian Vital Statistics Database

DALY – Disability-adjusted life years

GAD-7 – Generalized Anxiety Disorder 7

LGC – Latent Growth Curve

RMSEA - Root Mean Square Error of Approximation

TLI - Tucker-Lewis Index

WHO – World Health Organization

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Chapter 1, Introduction

Mental illnesses are a collection of disorders characterized by their impact on cognitive, behavioural, and emotion regulation functions (American Psychiatric Association, 2013; McIntyre et al., 2013). These illnesses are relatively common worldwide, and take on a number of different forms, including that of substance use disorders, mood disorders, psychosis, eating disorders, and intellectual disabilities (American Psychiatric Association, 2013; Whiteford et al., 2013). The global prevalence of mental illness is unknown, given the wide scope of conditions, symptoms, and surveillance systems. However, as per the Global Burden of Disease project, disability-adjusted life years (DALYs) are estimated to be 2,172.74 per 100,000 worldwide (Global Burden of Disease, 2016). Moreover, in 2015, 12.2% of participants in a population-based survey reported being diagnosed with a mood or anxiety disorder in Canada (The Daily: Statistics Canada, 2017). Mental illnesses primarily induce disability on the individuals they affect, as well as those around them. However, it is important to note that in recent years, mental illness has been a major driving factor in the reduction of Canada's average life expectancy. While the etiology of most mental illness is thought to be unknown (Global Burden of Disease, 2016), it is likely the result of an interaction between behavioural, societal, environmental, and genetic causes (Lewinsohn et al., 1998; Murray & Lopez, 1997).

Depression and anxiety

Depression is a mental disorder characterized by persistent feelings of sadness, feelings of hopelessness, and loss of interest in everyday life; anxiety, while often comorbid with depression, is more commonly characterized by periods of nervousness, panic, and fear (American Psychiatric Association, 2013). Depression and anxiety are the most common mental illnesses in Canada (The Daily: Statistics Canada, 2017). In Canada, the past 12 months

prevalence estimates of depressions and lifetime prevalence estimates were 4.7% and 11.2%, respectively (Knoll & MacLennan, 2017). The incidence of depression in Canada in 2019 was estimated to be roughly 3.2% (Global Burden of Disease, 2013), but the prevalence of past-year depression fluctuates throughout the lifespan but typically decreases with increasing age (Patten et al., 2015). Cases of depression typically onset in young adulthood (Kessler et al., 2007), but those that onset in adolescence are noted to be particularly severe should they persist throughout the lifespan (Wilson et al., 2015). In Canada, anxiety affects approximately 5%, respectively (Canadian Mental Health Association, 2014). These illnesses are most common among Canadians aged 15 to 24 years (Statistics Canada, 2013).

Depression and anxiety in youth

The most common conditions under the umbrella term of "mental health" among youth include depression and anxiety (Michaud & Fombonne, 2005). In addition, the highest rates of mental health problems are recognized to be in youth, and the majority of mental disorders are onset in adolescence (~50%) and early adulthood (~75%)(Global Burden of Disease, 2016; Kessler et al., 2007). Navigating mental health in youth may be especially difficult because the hormonal fluctuations associated with puberty often result in negative affect and angst, which are different but may resemble some symptoms of mental illness (Thapar et al., 2012). As such, mental health problems may be less detectable among youth or may be excused as normal symptoms of pubertal status. In addition, the stigma associated with seeking help for mental health care is also highly prevalent in schools and other youth-centred environments (Aguirre Velasco et al., 2020; Radez et al., 2021). Complicated emotions associated with mental health problems can manifest in feelings of mistrust, isolation, hopelessness, and disorder (e.g., reduced social cohesion). These feelings may also make it more difficult for youth to seek treatment and

subsequently may worsen mental health (Wilkinson, 1999). As a result, the large majority of youth mental health conditions go untreated or undetected (Children's Commisioner for England, 2016; Kutcher & Venn, 2008).

It is especially troublesome when mental health disorders in youth go untreated because the effects of untreated mental health are long-lasting. Youth are particularly vulnerable because they are still developing emotionally and physically, and untreated mental health issues in youth may lead to issues with social, emotional, and even physical development (Kutcher & Venn, 2008; McEwan et al., 2007). This is important because problems in youth can lead to resounding issues throughout the lifespan and into adulthood, causing a larger and longer health burden on the individual and the health care system. In addition, self-medication may occur when people with depression or anxiety attempt to mitigate their symptoms with substance use (Neale & Kendler, 1995; Scherma et al., 2018). These behaviours are important because youth are especially vulnerable to addiction and may form habits that permeate into adulthood (Paglia & Room, 1999).

Poor mental health can manifest in many ways and can lead to death (Harris & Barraclough, 1998; Hawton et al., 2013; Sherman et al., 2007). For example, depression is a major risk factor for suicide (Cheung & Dewa, 2006) and drug and alcohol use (Sullivan et al., 2005; Volkow, 2004). Depression and anxiety may result in increased vulnerability to negative emotions and difficulty coping. Substance use, in some situations, can be used as a coping mechanism for dealing with these emotions. Moreover, self-medication may occur when people with depression or anxiety attempt to mitigate their symptoms with substance use (Neale & Kendler, 1995; Scherma et al., 2018). Excess substance use is a cause of conditions such as

alcohol-related liver disease and drug dependence and can lead to subsequent death by those causes.

Deaths of Despair

Work by economists Case and Deaton identified decreases in life expectancy and increases in mortality in working aged US adults, which they speculate are owing to increases in premature deaths caused by drug overdose, alcohol-related liver disease, and suicide. Collectively, Case and Deaton referred to these deaths as 'deaths of despair'. Similar trends (i.e., reductions in life expectancy and increases in mortality among working aged adults) are notable in Canada. For example, in the general population from 1990 to 2019, deaths due to substance use (e.g., drug overdose, alcohol poisoning) have increased by 156.1%, and deaths due to mental disorders (e.g., suicide) have increased by 40.7% (Global Burden of Disease, 2013). This represents an alarming increase in deaths of despair rates in Canada.

It is important to note, however, that the term "deaths of despair" can be seen as a misleading label. The term itself implies despair as the direct etiology of deaths owing to suicide, alcohol-related liver disease, and drug overdose, when the direct events preceding such deaths are more likely multi-faceted. For example, deaths due to drug overdose are more likely attributable to contaminants in drug supplies (e.g., synthetic opioids such as fentanyl) than despair (Dowell et al., 2017). Some critics of the term have also warned against the use because implying these deaths are caused by despair disregards the structural factors that contribute to risk of such deaths. As such, the term deaths of despair in this thesis is an umbrella term used to describe deaths attributable to suicide, drug overdose, and alcohol-related liver disease, but not to imply that these deaths are solely attributable to despair.

Socio-economic status

Mental health and overall well-being are shaped by many social and economic factors. The social determinants of health, and specifically, socio-economic status, can contribute to risk of depression, anxiety, and deaths of despair. Socio-economic status, an absolute measure of economic and social status in society, can contribute to the risk of adverse health (Baker, 2014). Most typically, measures of socioeconomic status are constructed based on absolute income, employment, and education. Unsurprisingly, these factors contribute to health and mental health, with higher income, education, and job security typically associated with better health outcomes (Lisa F Berkman et al., 2014; I.-H. Kim et al., 2012; Leigh, 1983; Virtanen et al., 2005; Zhang & Xiang, 2019). The effects of socioeconomic status on health and mental health have been well-documented in the literature; however, studies of adolescent mental health highlight associations between not only socioeconomic status and past-year mental health, but also between relative socioeconomic position and mental health (K. A. McLaughlin et al., 2012).

Socio-economic position

A longstanding body of research has demonstrated that our absolute social and economic position greatly impacts health (J. Lynch & Kaplan, 2000). Socio-economic position relates to our relative position within society, as compared to socio-economic status, which relates primarily to absolute social and economic conditions. In terms of socio-economic position, generally the higher one's socio-economic position relative to others the better their health (J. Lynch & Kaplan, 2000). Conversely, lower socio-economic position contributes to poor health. This theory can be applied in studies on mental health. Investigating how socio-economic positions affect mental health is important and research findings may help to inform social programming and interventions to reduce the burden of these conditions (Muntaner et al., 2004).

By identifying risk factors for mental health (e.g., depression and anxiety) and deaths of despair, policy and programs that target those may be at an increased risk of such conditions can be promoted. This thesis studies income inequality, a contributor to socio-economic position, because income inequality has been identified as a risk factor for adverse mental health (Burns et al., 2017; Fan et al., 2011; I Kawachi & Kennedy, 1999; Ichiro Kawachi et al., 1994; Pabayo et al., 2014).

Social determinants of health framework

The social determinants of health framework have been used as a conceptual model for understanding mental health. The social determinants of health framework involves the socio-economic and political context of a health issue and the way they fit within society (Solar & Irwin, 2010). One primary facet of the social determinants of health framework is that the contextual and personal factors contribute to a person's health; and the structures and context surrounding those determinants of health contribute to social inequities, with social inequities being defined as unjust differential accessibility to resources sourced from disparities in demographics such as race, gender, or income (Pickett & Wilkinson, 2017). Social inequities may then also act to influence one's health, and, in particular, their mental health.

Social determinants of mental health framework

The social determinants of mental health framework was developed to highlight the importance of the social determinants of health in understanding common mental disorders (Allen et al., 2014). This model incorporates aspects from the social determinants of health framework, which conceptualized the conditions in which people live, work, and age (World Health Organization (WHO), 2010), as previously discussed. The social determinants of mental health framework specifically draws on multi-level frameworks, employing aspects from the life-

course approach (i.e., to better understand how early life experience shape health over time), community-level contexts (i.e., to better understand those resources and characteristics that shape the health of communities), and country-level contexts (i.e., to better understand political, social, and economic structures that contribute to population health) (Allen et al., 2014). The work outlined in this thesis can be conceptualized using a social determinants of mental health framework.

Adapted from Fisher and Baum (See Figure 1-1, Fisher & Baum, 2010; World Health Organization Commission on the Social Determinants of Health, 2008), the illustrated conceptualization for the social determinants of mental health in this thesis is outlined in Figure 1-2. Per this figure, distributions of social and economic conditions (e.g., income inequality) contribute to the burden of mental health disorders. Such conditions are associated with exposure to proximal stressors including absolute income, employment, social cohesion, and perceived safety, which then contribute to one's risk of stress or psycho-social well-being. Ultimately, it is that association that drives the need to cope, for example, by using drugs or alcohol, which can contribute to one's risk of deaths of despair; or contributes to the risk of poor mental health, such as in depression or anxiety.

Further work has highlighted some key recommendations for future use of the social determinants of mental health framework. Recommendations from Alegria and colleagues highlight the need for: 1) understanding the negative consequences of this work (i.e., could identifying social determinants lead to further discrimination or stigmatization vis-à-vis deficit-focused or regressive approaches with the intent of "improving" human health); 2) longitudinal study designs; 3) clear definitions; 4) specific risk factors among key subgroups (i.e., different age, gender, racial/ethnic groups); 5) further simulation studies; 6) assessment of multi-pronged

interventions; 7) evaluations of current interventions for mental health; 8) a reframing of the

social determinants of mental health as resulting from structural inequalities rather than

individual behaviours; 9) improved dissemination for policymakers, patients, and clinicians

alike; and, 10) increased responsibility of decision-makers in improving population mental health

(Alegría et al., 2018). While these recommendations may appear onerous, it is not necessary to

appease all recommendations within one project. Instead, addressing, in part, some of these

recommendations may help to improve the strength and utility of future studies.
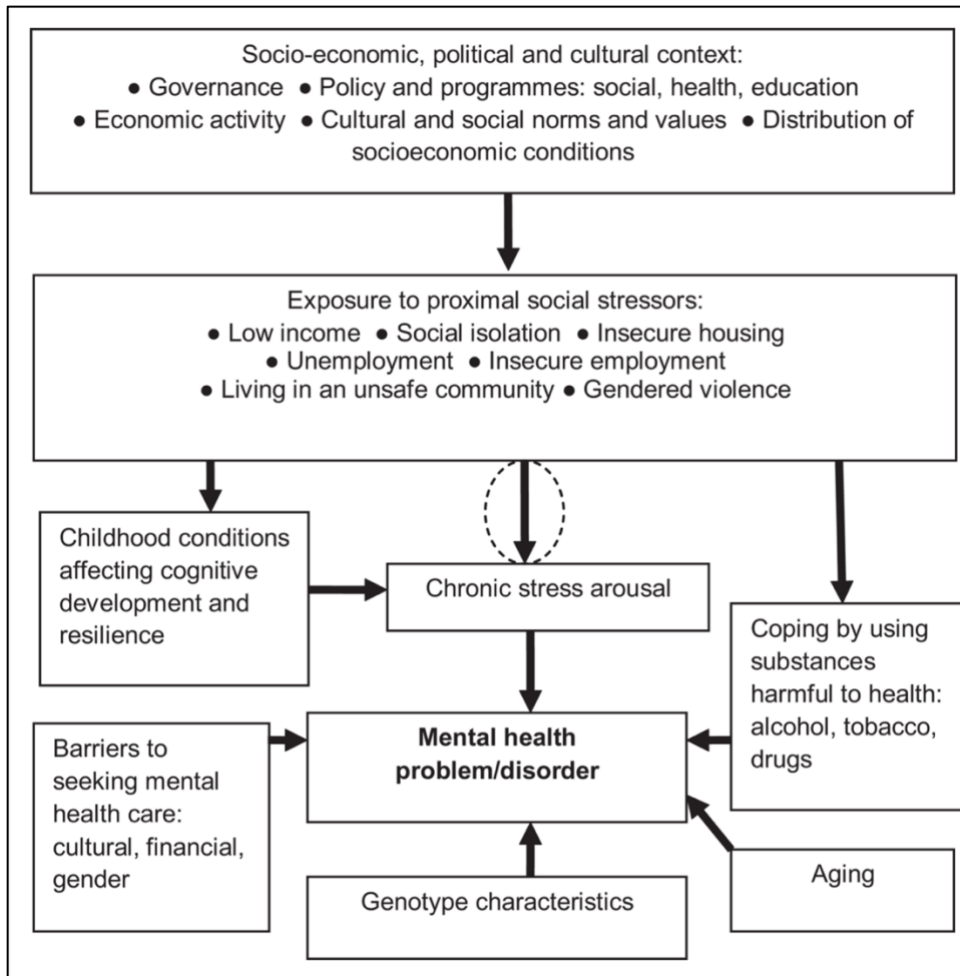
Figure 1-1. Diagram of the social determinants of mental health as adapted from the World Health Organizations Commission on Social Determinants of Health via Fisher & Baum 2010.
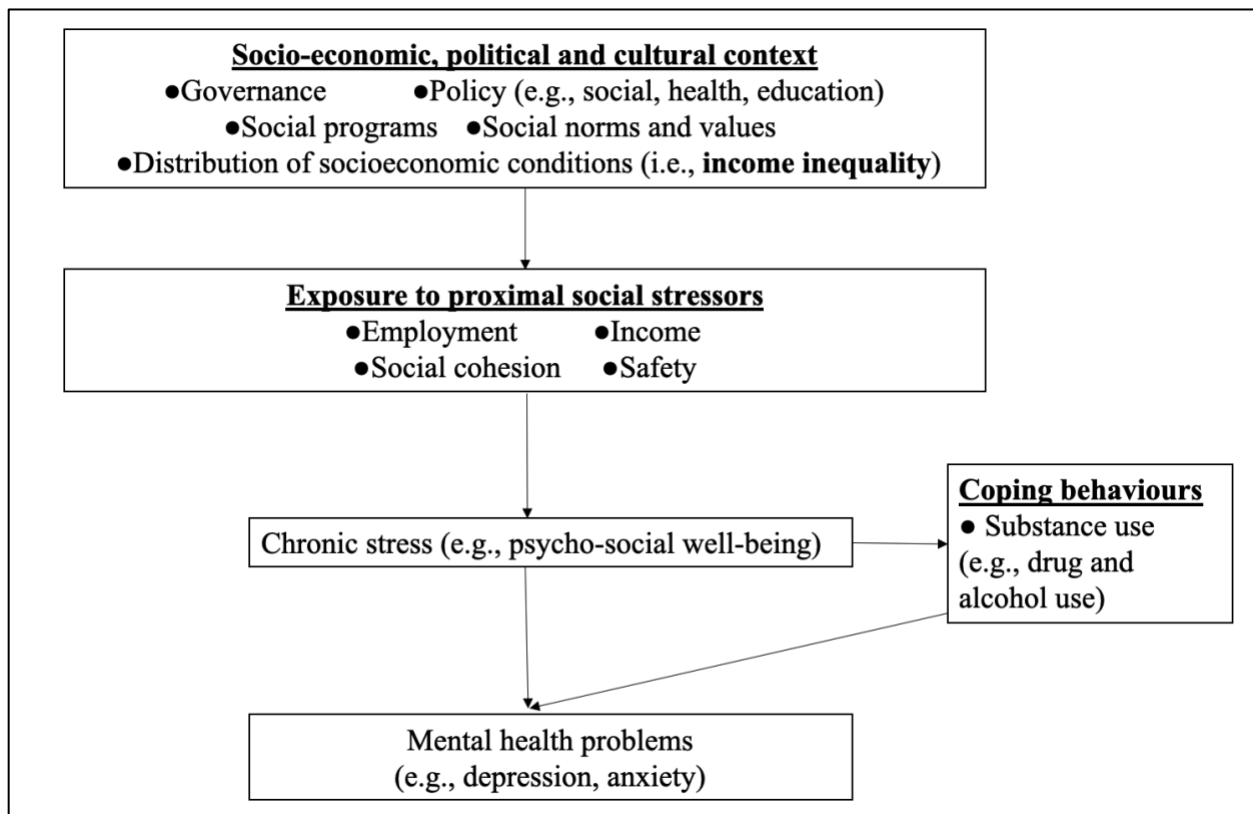
Figure 1-2. Applied diagram of the social determinants of mental health framework as employed in this thesis.

Social inequities and mental health

Empirical public health research indicates that relative and absolute deprivation (e.g., income inequality and poverty, respectively) contribute to mental health. The absolute deprivation hypothesis theorizes that absolute deprivation, such as being low- versus high-income or above or below the poverty line, has a significant impact on health. For example, numerous studies have examined the relationship between poverty and mental health (Belle & Doucet, 2003; Heflin & Iceland, 2009; Lund et al., 2010; Marshall et al., 2005; Ridley et al., 2020). Based on this literature, it is evident that poverty is a risk factor for depression and anxiety, as in line with the absolute deprivation hypothesis. However, some researchers argue

that relative deprivation and structural inequalities may also be important in terms of mental health (Eibner et al., 2004).

Income inequality

One factor contributing to socio-economic position and social inequities is income inequality. Income inequality is described as the differences in income within a given group or area. Relative income inequality refers primarily to the disproportionality of the differences in income within a given group or area (Berkman et al., 2014). For example, a wide gap in income inequality suggests that some of a given sample has a disproportionately higher or lower income than others. In contrast, a narrow gap in income inequality suggests that there is not a wide distribution of incomes within a given group or area (I Kawachi & Kennedy, 1999). In contrast, absolute income inequality refers to the fixed differences in income within a given group or area. For example, absolute income may refer to those above versus below the "poverty line", whereas relative income refers to gaps between the highest earners and the lowest earners. Income inequality can be considered a vital component of the social determinants of health and the social determinants of mental health frameworks. Income inequality would be classified as a contextual determinant of health because the degree of income-inequality is usually measured in terms of an area (e.g., neighbourhood, Census metropolitan area) and can influence one's socioeconomic position.

The income inequality hypothesis

The income inequality hypothesis, theorized by G.B. Rodgers in 1979 (Rodgers, 1979), supposes that a person's health is not just influenced by their level of income, but rather the distribution of incomes in the area in which they live (De Maio, 2014; I Kawachi & Kennedy, 1999). Rogers describes that income inequality contributes to the health of populations and is a

risk factor independent of absolute income. Notably, research demonstrates that absolute income is not linearly associated with health (e.g., in terms of life expectancy), and so distributions of relative income inequality may explain some variation in health. For example, at a certain level of absolute income, the relationship is more likely asymptotic (De Maio, 2014; Rodgers, 1979). As such, at the tail-end of the distribution, where incomes are highly unequal, people in the area may experience worse health outcomes. This supposition has been studied in several fields, including economics, social epidemiology, and medical sociology, and has been supported in well over 100 empirical studies (De Maio, 2014), garnering support in multiple contexts and countries (Chiavegatto Filho et al., 2013; Fan et al., 2011; Pabayo et al., 2014, 2016). A key takeaway from the income inequality hypothesis is that increases in income inequality can lead to segregation and polarization within and between communities, which contributes to the risk of ill health.

The income inequality hypothesis has been met by some criticism. Of note, David Coburn, renowned sociologist, has argued that income inequality is actually part of the causal relationship between neoliberalism and adverse health consequences, rather than being causal in and of itself (Coburn, 2004). Coburn suggests that research move beyond looking at income inequality as a causal factor for ill health, and instead focus on a broader set of upstream political, social determinants of health (Coburn, 2004). Defendants of the income inequality hypotheses highlight the fact that the studies that demonstrate that income inequality does not play a key role in population health are predominantly ecological studies by design (Subramanian & Kawachi, 2003); however, this has changed, with an increasing number of multi-level studies, which include both area-level and individual level data. While it is likely that

neoliberalist doctrines do affect health, the focus of the thesis will be on the relationship between income inequality as an exposure for predicting poor mental health.

Measuring income inequality

In public health research, relative income inequality is often measured using the Gini coefficient (De Maio, 2007; Kawachi & Kennedy, 1999; Left Business Observer, 1993). The Lorenz curve is a graphical representation of the proportion of the total income of the population (y-axis) that is cumulatively earned by the lowest earners in the population. The Lorenz curve illustrates perfect equality in income, and the distance between actual income and perfect equality. Consequently, the Gini coefficient can be approximated by dividing the area between the Lorenz curve of a given distribution and the distribution line of incomes within an area by the area under the distribution line (See Figure 1-3).
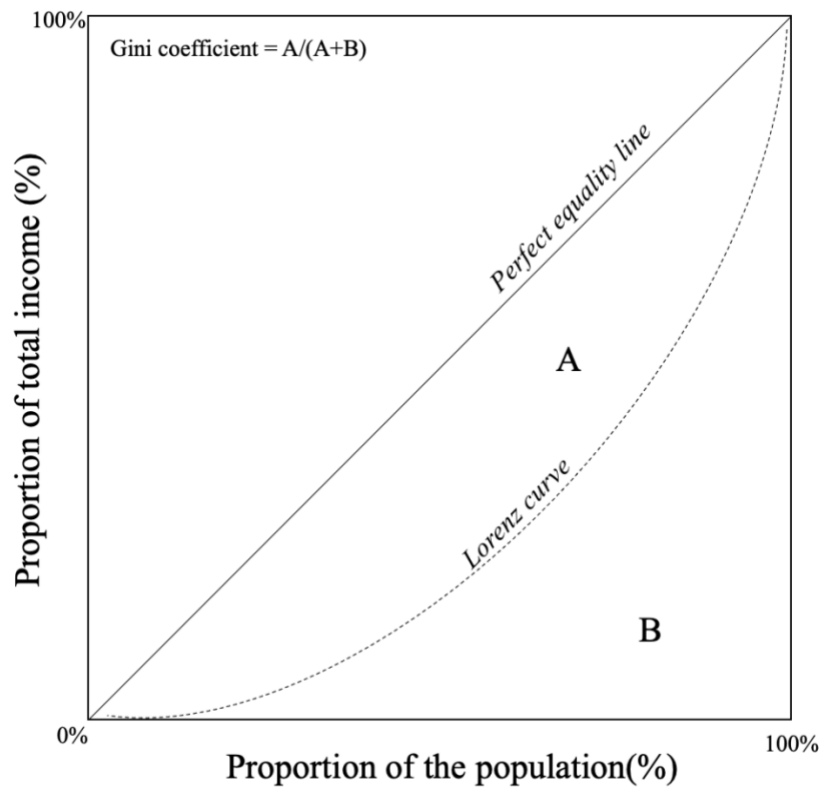
Figure 1-3. Conceptualization of the Gini coefficient using the Lorenz curve.

The Canadian context

While income inequality across Organisation for Economic Co-operation and

Development (OECD) countries has largely remained stagnant (OECD, 2023), in Canada, the

Gini coefficient has been increasing from 1990 to 2019 (Breau, 2014; Statistics Canada, 2020b).

More specifically, there have been marked increases in income inequality within neighbourhoods

in Canadian cities since the early 1990s (Hulchanski & Murdie, 2013). Between 1990 and 2018,

there was a 5.9% increase in the average Gini coefficient in Canada (Statistics Canada, 2020b).

Moreover, an international comparison of countries found that Canada was more stagnant than

the majority of other nations in counteracting the increasing levels of income inequality

(Hulchanski & Murdie, 2013). As of 2018, the Gini coefficient of Canada is on par with

countries such as Australia, Sweden, and Germany; and is slightly lower than the United

Kingdom and the United States (Canadian Institute for Health Information, 2019). Within

Canada, the Gini coefficient ranges from 0.285 to 0.331, in New Brunswick and Ontario,

respectively (Statistics Canada, 2020b). While there is little variation between provinces, the

Gini coefficient has been rising markedly among Ontario and Alberta. Therefore, the recent

increase in income inequality presents an urgent need to investigate the effects of these trends on

health in Canada (Statistics Canada, 2020b). In terms of smaller area units, such as within

counties, in the decade leading up to 2006, there was a 7.5% increase in the average Gini

coefficient across Canadian Census Divisions (Breau, 2014).

Income inequality and COVID-19

In March of 2020, the World Health Organization announced a global pandemic of

SARS-Cov-2, or COVID-19. The health, economic, and social effects of COVID-19 were

devastating worldwide. The onset of the COVID-19 pandemic was associated with work-from-

home orders, job loss, social isolation, ill health, all contributing to the risk of worse mental health. With such economic downturn, gaps in income inequality in Canada rose until the introduction of the Canadian Emergency Response Benefit (CERB) and Canadian Emergency Student Benefit (CESD), which functioned as unconditional cash transfers to alleviate some financial stress among working class and student Canadians. That said, in times of crisis, gaps in health, education, income, and other socio-economic indicators tend to widen. Based on past research, "shocks" to economic systems and other similar disasters are associated with increased harms associated with income inequality and widened disparities in health (Mohtadi & Castells-Quintana, 2021; Pega et al., 2015). Presumably, the same widened disparities are likely to apply to adolescents, who experienced increases in social isolation, mental health symptoms, and ill health associated with the COVID-19 pandemic (Craig et al., 2022). As such, it is important to investigate potential changes in the association between income inequality and adolescent mental health after the onset of the COVID-19 pandemic.

Politics, power, and income inequality.

There are several factors that contribute to increases in income inequality, ranging from international factors, including neoliberal policies such free trade and globalization, to region-specific factors such as low and stagnant minimum wage (Dutt, 1984; Huber & Solt, 2004). Unsurprisingly, government policies play a major role in trends in inequalities. Some literature suggests that ties between politics and income inequality are brought about by increasing political polarization (Duca & Saving, 2016; Gu & Wang, 2022; Winkler, 2019). More specifically, empirical research have indicated that there income inequality is significantly associated with greater political polarization over the past thirty years (Gu & Wang, 2022). This association makes conceptual sense, when considering that income inequality is tied to

reductions in social mobility and social conflicts that can drive political unrest (Alesina & Perotti, 1996). Political unrest is also associated with increases in the erosion of social cohesion (Edlund & Lindh, 2015), distress, poor mental health, and increased risk for deaths associated with homicide and suicide (Lester, 1998).

Higher socio-economic status is associated with greater access to power. For example, the majority of elected officials tend to be wealthy, high earning, white men (Carnes, 2020; Muriaas, 2019; Schäfer, n.d.). As such, political decision-making powers typically fall into those with inherently more power, but not necessarily those representative of the majority of North Americans. Social inequities, such as structural racism and sexism, can further prevent those who are working class or are visible or gender minorities, from engaging in such politics, and are noted to be attributable to time, financial, and other constraints (Schäfer, n.d.), as such the working class is typically under-represented in political offices in North America.

While political structures become increasingly more polarizing across Canada (Cochrane, 2010; McLay & Ramos, 2021), the existing literature highlights that political status may not be as dichotomous in the Canadian context as in the United States, but more likely exists within two dimensions: social (right and left) and economic (right and left) (Choma et al., 2010). Regardless, political inequality is likely more associated with income inequality than polarization. Political inequality is introduced based on a lack of representation of middle- and lower-income classes within Canada and may further perpetuate income inequality and other disparities. The lack of representation re-enforces traditional power dynamics across Canada- specifically in terms of who are and are not able to access power to make decisions. Seemingly, decisions made by the wealthiest are likely more reflective of the values of those who are the

most wealthy, perpetuating inequities for marginalized citizens. As such, these decisions may not reflect the challenges faced by the majority of Canadians.

Policies such as minimum wage increases or basic income packages may reduce income inequality; however, cost is a major considering factor in political decision-making. Government and economic discomfort with the concept of cash transfers and basic income is driven by persistent myths about how such funds would be used (Gentilini et al., 2019; Handa et al., 2018). However, research has demonstrated that the funds provided to the lowest earners are circulated back into the economy because those lowest earners typically use the funds for goods and services that are needed to survive and flourish (Handa et al., 2018; Standing, 2007), whereas higher earners or those who are most wealthy may be more likely to save or invest these funds. This difference in values may lead those who are most wealthy and hold the most power to believe that those lower earners would act similarly, which is rarely the case. As such, misunderstandings drawn from under-representation of lower earners may hinder the political will to implement income inequality reducing programs.

Mechanisms by which income inequality contributes to mental health and deaths of despair

Divestment in Human Capital.

Income inequality is associated with decreased investments in human capital, meaning income inequality is associated with divestments in programs, policies, and organizations that improve human skills, knowledge, and experiences. Examples of human capital may include post-secondary education, health clinics, and job training. Societies that invest less in human capital, such as education or health, exhibit the largest social disparities and lower life expectancies worldwide (Ichiro Kawachi et al., 1997; Richard G Wilkinson, 1992). Essentially,

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the gaps between the highest and lowest earners increase at higher rates in societies where human capital sectors (e.g., health care, education, public health) are underfunded or defunded.

The relation between income inequality and divestments in human capital is subsequently associated with worsened health or mental health, because human capital sectors are typically those that improve health (Scheffler et al., 2010). In environments where cuts to education, health services, and social programs are made, the health of the people living in that space will suffer. This is especially true in areas with higher income inequality, where such resources are typically less accessible. Cuts to social, education, and health services have direct effects on the mental health of a population. For example, access to mental health services may be an important mediator to consider in future research considering that the existing literature has demonstrated that an association exists between access to mental health services and depression in adolescents (Masselink et al., 2018; Skrove et al., 2013; Werner-Seidler et al., 2017) and income inequality is associated with worsened access to mental health services (Bartram, 2019).

Divestments in health services and public health funding can make mental health services increasingly difficult to access and lack of access to mental health services has been shown to be associated with worsened depression, which could lead to subsequent increases in suicide attempts and deaths attributable to suicide. Moreover, divestments in harm reduction programs are associated with higher risk of deaths due to drug overdose (Irvine et al., 2019; Perrin, 2020). As such, increased income inequality associated with increased divestment in human capital may lead to increases in adverse mental health outcomes and deaths of despair.

Erosion of Social Capital

Social capital can be defined as the features in a given area or society that allow for social organization, such as in community participation, reciprocity, resource sharing, trust, and social

cohesion (Falk et al., 1999). High social capital is beneficial for all members within the area or society, whereas an erosion of social capital might lead to mistrust, worse social cohesion, and less community participation. Income inequality can lead to the erosion of social cohesion in that in more unequal societies, people may be less able to relate to their neighbours, resulting in feelings of mistrust and social isolation (I Kawachi & Kennedy, 1999; Pearce & Davey Smith, 2003). These feelings are, in turn, strongly associated with poorer health and health behaviours (e.g., smoking, alcohol use) and increased mortality rates (Ichiro Kawachi et al., 1997; Pattussi et al., 2016), partially due to increases in stress associated with low social capital.

Similarly, existing evidence demonstrates that reduced social cohesion is associated with an increased risk of psychological distress and poor mental health (Papachristou et al., 2019; Walton, 2018; Williams et al., 2020), and that income inequality is tied to social cohesion (Fone et al., 2014; Ichiro Kawachi & Kennedy, 1997). The literature demonstrates that people who feel less connected to their social environment exhibit more depressive characteristics, such as loneliness and apathy (Fone et al., 2014; Paczkowski & Galea, 2010). Moreover, these feelings can manifest in harmful, and potentially deadly, ways including suicidality and coping via self-medication using drugs or alcohol (Volkow, 2004). Thus, income inequality can erode social cohesion, which may result in increased risk of adverse mental health outcomes and, potentially, deaths of despair. Further, there is a reciprocal relationship between divestment in human capital and social cohesion, such that in societies where there is erosion of social cohesion there may be less government investment in social programs, and in spaces where there are fewer social programs people may feel less connected and trusting of their social environments (Jenson & Saint-Martin, 2003; Ichiro Kawachi & Berkman, 2000).

Theory of Social Comparison

Feelings of inferiority due to social comparison may mediate the association between income inequality and adverse health (Kawachi & Kennedy, 1999). There are two main facets to the theory of social comparison, downward and upward. It is noted that people with lower social positions (e.g., lower earners), or relevant socioeconomic standing within a society, look "upward" at those in higher social positions (e.g., higher earners). Reportedly, comparing "upward" can lead to feelings of shame or feelings of inferiority. Also, people with higher social positions (e.g., higher earners) may look "downward" on those with lower social positions (e.g., lower earners) and believe that they are comparatively "better". However, this may also lead people to feel like they do not relate to their peers, thus the theory of social comparison is inherently tied to the erosion of social cohesion postulation. It should be noted that most of the literature assessing the theory of social comparison demonstrates support in favour of the upward aspect, but not the downward aspect of the theory (Gerber et al., 2018). That said, not only income comparisons drive the theory of social comparisons and social comparisons can occur even among those that earn the same income. Specifically, Kawachi and Kennedy refer to "cultural consonance", or the degree to which one's beliefs and behaviours align with their perceived social norms (I Kawachi & Kennedy, 1999). For example, those who believe their values and beliefs are more similar to that of societal norms are less likely to be depressed when compared to those whose beliefs and values are misaligned with societal beliefs and values (Dressler et al., 2017).

A systematic review and meta-analysis on the topic reported that the majority of existing studies showed that income inequality contributes to the risk of depression (Patel et al., 2018). The authors of the review propose some reasons why income inequality may contribute to the

risk of depression, ranging from responses to the basic components of neo-materialist policies to social comparisons between groups to individual-level psychological distress or shame. Past research has indicated that feelings of shame and inequality are undoubtedly linked to mental illness (Wilkinson & Pickett, 2017). Overall, a perception that one's social position is lower or different relative to those around them is noted to be psychosocially damaging, leading to poor mental health (Ribeiro et al., 2017). Further, it is possible that these same mechanisms may contribute to deaths of despair, considering that adverse mental health is strongly associated both with substance use and suicidality (Esposito-Smythers & Spirito, 2004; MacPhee & Andrews, 2006; Thapar et al., 2012).

Chapter 2, Literature reviews

Two distinct literature reviews to identify gaps in the field of income inequality and mental health and income inequality and deaths of despair were conducted for this thesis. Both reviews used methodology adapted from the Cochrane Handbook for Systematic Reviews (Higgins & Green, 2011), and followed the reporting guidelines in the PRISMA Checklist (Wardlaw, 2010). Please note that these reviews were conducted by one independent reviewer. The methodology and results of each review are described in the proceeding paragraphs.

Income inequality and mental health

Research question

The research question informing the current review followed a participant(s), exposure(s), comparison(s), and outcome(s) (PECO) framework (Morgan et al., 2018). The question in this case was "Do adolescents living in areas with a higher level of income-inequality have worse mental health outcomes when compared to those living in areas with a lower level of income-inequality?".

Search strategy

The inclusion criteria for this review were developed *a priori* and were as follows:

1. The study must have some measure of relative income inequality

2. The study sample must include adolescents and adolescents must be independently assessed

3. The study must have mental health-related outcomes, such as: depression, anxiety, emotional distress

4. The study must have some measurement of the degree of relation between income inequality and adolescent mental health (e.g., correlation, odds ratio)

Four academic databases were searched to inform the current review, including: CINAHL (EBSCO), Psyc Info (EBSCO), MEDLINE (Ovid), and Embase (OVID). The search strategy was modified for each search as operators varied by dataset; however, the search terms used were consistent. Search terms included: income inequality, adolescent or teenage, and mental health (including depression and anxiety).

An initial search was conducted on May 26, 2020 and was repeated on November 12, 2022. Eligible study citations from each database were exported into Covidence (Cochrane, 2019), an online systematic review management platform. Duplicates were removed from the original number of studies automatically using Covidence. Following title and abstract screening, studies that did not meet the pre-specified inclusion criteria were removed from the review. Next, the full-text articles were screened to determine eligibility for review. In the full-text review process, articles were identified and the reasons for the exclusion of studies that ultimately did not fit the inclusion criteria were reported. Reasons included:

i.   Duplicate: The study was not removed by Covidence but was included more than once in the list of eligible studies. In cases where duplicated studies were determined to have not met eligibility criteria following full-text review, one study was assigned an alternative reason for exclusion, and the other assigned "duplicate"

ii.   Irrelevant study population: The study population did not include or did not [1]independently assess adolescents, by any operational definition [i.e., typically including the chronological ages of 10 and 18 (Curtis, 2015)].

iii. Irrelevant outcome: The outcomes in the study did not include any form of a mental health outcome.

iv.   Irrelevant exposure (e.g., absolute income): Relative income inequality was not assessed in the study.

A summary of characteristics table was used to structure the data extraction process. Data from the eligible studies were extracted into Microsoft Excel (Microsoft Office, 2016). These data extracted included: citation, study period, data source, study design, exposure measure, outcome measure, analytic method, findings, direction of association, and additional notes. The summary of characteristics table was used to conduct a narrative synthesis of the existing literature on income inequality and adolescent mental health. The narrative synthesis in this review used descriptive statistics (e.g., proportions and frequency measures) to evaluate the following elements: study location, study period, exposure measures, outcome measures, and the direction of association with the outcome.

Results

Following an initial search of four academic databases, 164 citations were exported into Covidence for screening. Among these, 66 were immediately identified to be duplicates and were excluded from the review. The resulting 98 citations were screened for title and abstract content, using the aforementioned inclusion criteria to identify relevant studies for review. Of these, 61 studies were deemed irrelevant, leaving 37 studies eligible review. Upon full-text review, an additional 25 studies were found to be irrelevant for review. A second search conducted in November, 2022, yielded 15 additional articles, five of which were relevant for full-text review. Upon full-text readthroughs, these five studies were excluded. The reasons for exclusion of the 11 studies are available in Appendix B, Supplemental Table B-1. The remaining 11 studies were reviewed.

Of these 11 studies, 10 used a cross-sectional study design (with $n=4$ using repeated

cross-sectional designs) and the remaining study used an ecological study design. Income

inequality was most commonly measured using either the Gini coefficient or Gini index ($n=5$).

Other measures included the 80/20 ratio ($n=3$), self-reported feelings of income inequality ($n=1$),

and the squared coefficient of variation in incomes ($n=1$). The majority of studies ($n=6$) used

depression as an outcome, three used anxiety, four used a broad mental health measure (e.g.,

self-reported mental health, measures of psychosomatic stress as a proxy for mental health), and

one used emotional distress. Most studies found a positive correlation between income

inequality and mental health measures, meaning that higher income inequality was generally

associated with worse mental health. Of these, seven studies were able to demonstrate statistical

significance, based on a threshold of $p < 0.05$. Three of the six studies showed that higher

income inequality and was associated with a statistically significantly increased risk of

depression. Similarly, two of the four studies looking at income inequality and broad mental

health measures identified that higher income inequality was associated with a significant

increase in poor mental health. Moreover, two of the three studies on income inequality and

depression identified a significant association between income inequality and depression. The

study on income inequality and emotional distress demonstrated a significant association

between the two. Further details about the studies eligible for review are available in Table 2-1.

Narrative synthesis

Use of validated measures for mental health

The majority of existing studies used self-reported mental health as a means of

identifying mental illness among adolescents. This is important, as self-report measures can be

invalid due to reporting biases (e.g., social desirability bias, recall bias) (Grimm, 2010). Future

studies should use validated measures of mental health outcomes to ensure that the measures used accurately reflect mental health status of their sample.

Use of cross-sectional study design

The literature search yielded no longitudinal studies exist that investigate the association between income inequality and adolescent mental health. This is a limitation of the existing research, given that cross-sectional studies are incapable of identifying a temporal association between an exposure and an outcome. Longitudinal research is necessary to better understand the association between income inequality and adolescent mental health.

Table 2-1. Summary of characteristics table for the review on income inequality and adolescent mental health.

Authors	Published Year	Study design	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
Vilhjalmsdottir, Arndis; Bernburg, Jon Gunnar; Gardarsdottir, Ragna B.; Sigfusdottir, Inga Dora	2018	Repeated cross-sectional	Individual-level, school-level, community-level	Multi-level linear regression	Gini coefficient at the community level	Anxiety and depression	Community income inequality was associated with an increase in anxiety in 2006, when the country's income inequality was unusually high, but not in 2014. In 2014, a time of economic prosperity in Iceland, the authors found that the relationship between community income inequality and depression is reversed in 2014	Yes	Income inequality was associated with an increase in anxiety, but not depression
Vilhjalmsdottir A.; Gardarsdottir R.B.; Bernburg J.G.; Sigfusdottir I.D.	2016	Repeated cross-sectional	Individual-level, neighbourhood-level	Multi-level linear regression	Measured as mean disposable equivalized income, including capital gains, of the 20% lowest income households with that of the 20% highest-income house- holds in the community (a 20/80 ratio) in neighbourhoods	Emotional distress	As income inequality in the community increases, emotional distress among adolescents in the community grow	Yes	Income inequality was associated with an increase in the outcome
Vilhjalmsdottir A.; De Clercq B.; Gardarsdottir R.B.; Bernburg J.G.; Sigfusdottir I.D.	2019	Repeated cross-sectional	Individual-level, community-level	Multi-level linear regression	Measured as mean disposable equivalized income, including capital gains, of the 20% lowest income households with that of the 20% highest-income house- holds in	Anxiety and depression	A decrease in community income inequality is related to a decrease in anxiety among adolescents, but not for depression.	Yes, for anxiety; no for depression	Income inequality was associated with an increase in the outcome

Authors	Published Year	Study design	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
					the community (a 20/80 ratio) in communities				
Sun P.; Unger J.B.; Palmer P.; Ma H.; Xie B.; Sussman S.; Johnson C.A.	2012	Cross-sectional	Individual	Linear regression	Self-perceived relative income relative to others (SPRII-S) and self-perceived relative income relative to the student's own past	Self-reported depression	Those students who reported having a somewhat lower income compared to others had a significant increase in likelihood of self-reported depression (girls and boys)	Yes	Income inequality was associated with an increase in the outcome
Rivenbark J.G.; Copeland W.E.; Davisson E.K.; Gassman-Pines A.; Hoyle R.H.; Piontak J.R.; Russell M.A.; Skinner A.T.; Odgers C.L.	2019	Cross-sectional	Individual level	Linear regression	80/20 ratio	Mental health	80/20 ratio was significantly related with adolescent mental health independently, but not when controlling for other factors	Yes, but only in bivariate analyses	Income inequality was associated with an increase in the outcome
Riehm K.E.; Latimer E.; Quesnel-Vallee A.; Stevens G.W.J.M.; Gariepy G.; Elgar F.J.	2019	Cross-sectional	Country-level, individual-level	Linear regression	Gini coefficient	Self-reported mental health	Gini was not associated with self-reported metal health	Not significant	No effect (b=0.00)
Quon E.C.; McGrath J.J.	2015	Cross-sectional	Individual level, school level	Linear regression	Income inequality was measured using the squared coefficient of variation,	Self-rated mental health (depression, anxiety)	Income inequality is associated with self-reported mental health outcomes	Not significant	Income inequality was associated with an increase in

Authors	Published Year	Study design	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
					(SD/N)2, of each school district				the outcome
Pickett K.E.; Wilkinson R.G.	2007	Ecological	Country-level, State level	Correlation	Gini coefficient	Mental health	Higher income inequality was significantly correlated with worse mental health outcomes among US states	Yes	Income inequality was associated with an increase in the outcome
Pabayo R.; Dunn E.C.; Gilman S.E.; Kawachi I.; Molnar B.E.	2016	Cross-sectional	Neighbour-hood level, individual-level	Multi-level linear regression	Gini index	Depressive symptoms	Higher income inequality is associated with depressive symptoms among females, but not males.	Yes, for girls	Income inequality was associated with an increase in the outcome
Kim Y.; Hagquist C.	2018	Repeated cross-sectional	Individual-level, year of study	Linear regression	Gini coefficient	Psychosomatic symptoms (proxy for mental health problems)	Gini coefficient positively predicted psychosomatic symptoms, but the findings were not significant.	No	Income inequality was associated with an increase in the outcome

Income inequality and deaths of despair

Research question: The research question for this review was "Do people living in areas with a higher level of income inequality have a higher risk of Deaths of Despair when compared to those living in areas with a lower level of income inequality?".

The methods of this review were adapted from the Cochrane Handbook for Systematic Reviews (Higgins & Green, 2011) and the PRISMA Checklist (Wardlaw, 2010). The research question informing the current review followed a participant(s), exposure(s), comparison(s), and outcome(s) (PECO) framework (Morgan et al., 2018).

Search strategy

The inclusion criteria for this review were developed *a priori* and were as follows:

1. The study must have some measure of income inequality

2. The study must have one of the following outcomes (i.e., Deaths of Despair)

    a. Completed suicide or self-inflicted death;

    b. Mortality due to drug overdose; and/or,

    c. Mortality due to alcohol-related liver conditions.

3. The study must have some measurement of the degree of relation between income inequality and a Death of Despair (e.g., correlation, odds ratio)

Four academic databases were searched to inform the current review, including: CINAHL (EBSCO), Psyc Info (EBSCO), MEDLINE (Ovid), and Embase (OVID). The search strategy was modified for each search as operators varied by dataset; however, the search terms used were consistent. The search terms included income inequality, relative deprivation, economic deprivation, income, and suicide, death, mortality, alcohol, liver disease, overdose, and drug poisoning.

The searches were conducted on May 14, 2020 and November 10, 2022. Eligible study

citations from each database were exported into Covidence (Cochrane, 2019), an online

systematic review management platform. Duplicates were removed from the original number of

studies using Covidence. Following title and abstract screening, studies that did not meet the pre-

specified inclusion criteria were removed from the review. Next, full texts of each remaining

eligible article were evaluated to determine eligibility for review. In the full-text review process,

reasons for exclusion were identified and reported. Reasons included:

i. Duplicate: The study was not removed by Covidence but was included more than
once in the list of eligible studies. In cases where duplicated studies were
determined to have not met eligibility criteria following full-text review, one
study was assigned an alternative reason for exclusion, and the other assigned
"duplicate"

ii. Irrelevant outcome: The outcomes in the study did not include any form of a
Death of Despair outcome.

iii. Irrelevant exposure (e.g., absolute income): Income inequality was not assessed in
the study.

A summary of characteristics table was used to structure the data extraction process. Data

were extracted from the eligible studies into Microsoft Excel (Microsoft Office, 2016). These

data extracted included: citation, study period, data source, study design, exposure measure,

outcome measure, analytic method, findings, direction of association, and additional notes. The

summary of characteristics table was used to conduct a narrative synthesis of the existing

literature on income inequality and Deaths of Despair. The narrative synthesis in this review

used descriptive statistics (e.g., proportions and frequency measures) to evaluate the following

elements: study location, study period, exposure measures, outcome measures, and the direction of association with the outcome.

Results

Following an initial search of four academic databases, 401 citations were exported into Covidence for screening. Among these, 64 were immediately identified to be duplicates and were excluded from the review. The resulting 337 citations were screened for title and abstract content, using the aforementioned inclusion criteria to identify relevant studies for review. Of these, 253 studies were deemed irrelevant, leaving 84 studies eligible review. Upon full-text review, an additional 61 studies were found to be irrelevant for review. A second search conducted in November 2022, yielded 91 additional articles, five of which were relevant for full-text review. Upon full text readthroughs, four additional studies were excluded. The reasons for exclusion of these eligible studies are available in Appendix B, Supplemental Table B-2. A resultant 23 studies were reviewed along with an additional five studies that were identified as relevant by experts in the field. Details about the studies eligible for review are available in Table 2-2.

The majority of studies (n=23) reviewed used an ecological study design to assess the relationship between income inequality and Deaths of Despair. Remaining study designs included cross-sectional (n=2), case-control (n=1), and cohort (n=3) studies. The number of study designs exceeds the number of studies, given that one study evaluated their research question using a cross-sectional study design and an ecological study design (Nandi et al., 2006).

Of the studies reviewed, 24 of 26 used the Gini coefficient as a measurement of income inequality. Other measurements of income inequality included the Jasso's index on perceived income inequality (*n*=1), a ratio of the share of total income of the richest 20% in the population

to the share of the poorest 20% (*n*=1), and a measure from a 1983 paper by Carroll and Jackson (Jackson, 1983) (*n*=1). Overall, 20 of the studies used suicide as their Deaths of Despair outcome, four focused on drug overdose, and four detailed the effects of income inequality on alcohol-related liver disease deaths. Twenty studies identified that there was a positive relationship between income inequality and Deaths of Despair and fourteen studies found a significant relationship between income inequality and Deaths of Despair.

Suicide studies.

Among studies that detailed the relationship between income inequality and completed suicide, 12 found higher levels of income inequality were associated with an increased risk of suicide and, of these, six reached statistical significance to a level of $p < 0.05$.

Drug/overdose studies.

Among studies that detailed the relationship between income inequality and death due to overdose, all found higher levels of income inequality were associated with an increased risk of death due to drugs and/or overdose, and four of these reached statistical significance to a level of $p < 0.05$.

Alcohol-related liver conditions studies.

Among studies that detailed the relationship between income inequality and death due to alcohol-related liver disease, three found higher levels of income inequality were associated with an increased risk of death due to alcohol-related liver conditions, all of which demonstrating statistical significance to a level of $p < 0.05$.

Narrative synthesis

No studies evaluate Deaths of Despair as an aggregated category

None of the existing studies investigate the association between income inequality and Deaths of Despair as an aggregated category. To get a complete understanding of the risk of Deaths of Despair among those living in more unequal areas, it is important to use a variegated category.

Use of ecological study design

The majority of studies identified in this review used an ecological study design to quantify the relationship between income inequality and Deaths of Despair. This is a weakness, as noted by several authors in the existing literature, because individual-level analyses are necessary to develop strategies and policies to targeting individuals to alleviate the risk of Deaths of Despair. Moreover, results of ecological studies cannot be inferred onto individuals, and have an increased risk of bias due to ecological fallacy. The existing evidence on the relationship of income inequality within smaller areas, such as cities and neighbourhoods, on Deaths of Despair is rare.

Use of cross-sectional data

A large number of studies included this review used solely cross-sectional data to investigate the relationship between income inequality and Deaths of Despair. This is important, as cross-sectional data do not allow us to infer a temporal association between the exposure and the outcome. Longitudinal data are necessary in order to better understand the relationship between income inequality and Deaths of Despair.

Lack of Canadian studies

Of the existing studies investigating income inequality and Deaths of Despair, only a limited few were conducted in Canada (Auger et al., 2009, 2012; Wilkins et al., 2019). Of these, only one study used multilevel data (i.e., urban- and individual-level data). This study indicated that among immigrants in Canada, those living in areas with higher levels of income inequality were significantly more likely to die of alcohol-related causes during follow-up, in comparison to those in areas with low income inequality (Auger et al., 2012).

Table 2-2. Summary of characteristics table for the review on income inequality and Deaths of Despair.

Authors	Published year	Study design	Study period	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
Fernquist RM	2003	Ecological	1990-1993	Country-level	Modified generalized least squares (MGLS) estimation	Jasso's index on perceived income inequality	Suicide rates	Significant among 15-24 for females and males, significant among males for 25-34, both for 55+	Significant	Income inequality was associated with an increase in the outcome
Auger N.; Hamel, D.; Martinez J.; Ross, N,	2012	Cohort	1991-2001	Urban-level, individual-level	Survival analysis	Gini index	Suicide-related causes and alcohol-related causes of mortality	All income-inequality measures were predictive of a shorter time-to-mortality among those aged 25+	Yes, for alcohol-related mortality among immigrants only	Income inequality was associated with an increase in the outcome
Young, Thomas J.; French, Laurence A.	1996	Ecological	1979	HIS areas	Spearman's correlations	Income inequality measures by Carrol & Jackson (1983)*	Suicide rates	No robust association between income inequality and suicide rates	Not significant	Income inequality was associated with an increase in the outcome
De Vogli, R.; Gimeno, D.	2009	Ecological	1989-1997	Country-level	Linear regression	Gini coefficient	Death rate due to suicide and self-inflicted injuries	Income inequality is significantly associated with higher suicide rates per 100,000	Significant	Income inequality was associated with an increase in the outcome
Blakely, T.; Atkinson, J.; O'Dea, D.	2003	Cohort	1991-1994	Individual, regions (territorial, health regions)	Logistic regression	Gini coefficient	All cause deaths and suicide deaths	Lower Gini coefficient was associated with increased suicide risk, not sig in men or women ages 25-64	Not significant	Income inequality was associated with an increase in the outcome
Lin, C.-Y.; Hsu, C.-Y.; Gunnell, D.;	2019	Ecological	2004-2010	Neighbourhood-level	Linear regression	Coefficient of variation in household income within	Suicide	Higher coefficient associated with higher suicides (negligible)	Not significant	Income inequality was not associated with an

Authors	Published year	Study design	Study period	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
Chen, Y.-Y.; Chang, S.-S.						the neighbourhood				increase in the outcome
Huisman, M.; Oldehinkel, A. J.	2009	Ecological	2002	Country-level	Linear regression	The ratio of the share of total income of the richest 20% in the population to the share of the poorest 20%.	% of deaths due to suicide	Expected relationship between income inequality and self-inflicted mortality rates but only in former communist European countries	Yes (Some)	Income inequality was associated with an increase in the outcome
Suzuki, Etsuji; Kashima, Saori; Kawachi, Ichiro; Subramanian, S. V.	2014	Repeated cross-sectional	1975-2010	Individual, years, prefectures	Multi-level logistic regression	Gini coefficient	Suicide	No association between Gini and suicide across years in people aged 25-64	Not significant	Income inequality was associated with an increase in the outcome
Smith, Nathan Daniel Lucia; Kawachi, Ichiro	2014	Ecological	1975-2001	State-level	Linear regression	Gini coefficient (as per 1999)	Age-standardized suicide rates	No association between Gini and suicide across years	Not significant	Income inequality was not associated with an increase in the outcome
Rowe, Christopher; Santos, Glenn-Milo; Vittinghoff, Eric; Wheeler, Eliza; Davidson, Peter; Coffin, Philip; Coffin, Philip O	2016	Ecological	2010-2012	Census tract-level	Negative binomial regression	Gini coefficient	Opioid overdose	Higher Gini coefficient is associated with an increased mean number of overdose deaths	Significant	Income inequality was associated with an increase in the outcome
Modrek S.; Ahern J.	2011	Ecological	1995-2005	Canton-level	Poisson regression	Lagged Gini (i.e.,	Suicide, Alcohol-	Higher income-inequality (Lagged Gini	Yes, for ArLD but	Income inequality was associated

Authors	Published year	Study design	Study period	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
						cumulative over a 10-year period) and Contemporary Gini	related liver disease	only) was associated with alcohol-related liver disease, but not suicide	No for suicide	with an increase in the outcome
Minoiu, Camelia; Andre, Antonio Rodriguez	2008	Ecological	1982-1997	State-level	Generalized Method of Moments estimator	Gini coefficient	Suicide	Higher income inequality is associated with increased female suicide rates, but not for males or both among those 15-60 years of age	Yes, but only for females	Income inequality was associated with an increase in the outcome
Harris, Lauralee	2008	Ecological	1996-2005	County-level	Linear regression	Gini coefficient	Suicide	Positive relationship between adolescent suicide and income inequality	Not significant	Income inequality was associated with an increase in the outcome
Cerda, Magdalena; Ransome, Yusuf; Keyes, Katherine M.; Koenen, Karestan C.; Tardiff, Kenneth; Vlahov, David; Galea, Sandro	2013	Ecological	2000-2006	Neighbourhood-level	Multi-level logistic hierarchical modeling	Gini coefficient	Overdose	In crude analysis, income inequality was associated with an increased risk of death from analgesic vs heroin-induced overdose, but not when accounting for median income and other variables	Significant	Income inequality was associated with an increase in the outcome
Carcach, Carlos	2017	Ecological	2002-2012	Municipality-level	Poisson hierarchical models	Gini coefficient by municipality	Violence and violent suicide	A high level of income inequality increased the rate of total violence but was related to a lower tendency of completed suicide	Not significant	Income inequality was not associated with an increase in the outcome
Auger, N.; Zang, G.; Daniel, M.	2009	Ecological	1993-2003	Areas of health service	Linear regression	Gini coefficient tertiles	Suicide and alcohol-	Income inequality was associated with a significantly lower risk of alcohol-related	Significant	Income inequality was not associated with an

Authors	Published year	Study design	Study period	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
				delivery in Quebec			related mortality	mortality; but not significant for suicide		increase in the outcome
Kim, D	2016	Cohort	1979 to 1987	Individual-level, state-level	Ordinary least squares regression, OLS with fixed effects, instrumental variable analyses with fixed effects (only for state spending, welfare spending etc., not for income-inequality)	Gini coefficient for pre-tax based on the 1980 and 1990 census by state	Causes of death (suicide)	0.1-unit higher Gini coefficient was associated with a predicted probability for death by suicide (0.002, 95% CI 0.001, 0.002, P < 0.001) amongst working age adults	Significant	Income inequality was associated with an increase in the outcome
Hazemi-Galougahi, Mansouri, Akbarpour, Bakhtiyari, Sartipi, Moradzadeh	2018	Ecological	2010 to 2012	Province-level	Concentration Index/Concentration curve	Gini index by province	Per capita quintile for suicide rate ratio by income	The poorest quintile had the higher risk of completed suicide (RR 2.2, p<0.004). Gini index non-significant	No	Income inequality was not associated with an increase in the outcome
Veisani, Delpisheh, Valizadeh, Kikhavani	2019	Ecological	Not reported	Province-level	Linear regression	Gini coefficient by province	Completed suicide	Lower Gini coefficient was associated with decreasing trend in suicide, not statistically significant; curve of inequality demonstrated positive inequality in suicide death by Gini-coefficient	No	Income inequality was associated with an increase in the outcome

Authors	Published year	Study design	Study period	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
Dietze, Paul M; Jolley, Damien J; Chikritzhs, Tanya N; Clemens, Susan; Catalano, Paul; Stockwell, Tim	2009	Ecological	1999/2000	Local Government Area level	Logistic regression	Gini coefficient and the percent total income earned by the lowest earning 70% of households	Alcohol-attributable death	Income inequality positively associated with chronic alcohol-attributable death, but not associated with acute alcohol-attributable death	Yes	Income inequality was associated with an increase in the outcome
Nandi, Arijit; Galea, Sandro; Ahern, Jennifer; Bucciarelli, Angela; Vlahov, David; Tardiff, Kenneth	2006	Cross-sectional and ecological analyses	1999	Neighbourhood-level, individual-level	Multi-level logistic regression	Gini coefficient and percent of total income earned by lowest earning 70% of households	Drug overdose	Positive association between income inequality and rate of drug overdose explained by indirect effect of environmental disorder and built environment	Yes	Income inequality was associated with an increase in the outcome
Miller, Jeffrey R; Piper, Tinka Markham; Ahern, Jennifer; Tracy, Melissa; Tardiff, Kenneth J; Vlahov, David; Galea, Sandro	2005	Multi-level cross-sectional study	1996	Community district-level, individual-level	Multivariate, logistic regression and generalized estimating equations	Gini coefficient (and "percent of total income earned by lowest earning 70% of households within each community district")	Suicide	Suicide decedents more likely than accident controls to reside in neighborhoods with greater income inequality. Models with "age" treated as an effect modifier demonstrated that this relationship was only significant among young adults (15-34), and not older adults (35-64).	Yes	Income inequality was associated with an increase in the outcome
Galea, Sandro; Ahern, Jennifer;	2003	Multi-level case control study	1996	Neighbourhood-level,	Logistic regression	Gini coefficient	Overdose death	Income maldistribution significantly associated with risk of overdose,	Yes	Income inequality was associated

Authors	Published year	Study design	Study period	Levels	Analysis	Income inequality measure	Outcome	Findings	Significant	Direction
Vlahov, David; Coffin, Phillip O; Fuller, Crystal; Leon, Andrew C; Tardiff, Kenneth				individual-level				independent of individual-level or neighborhood-level variables		with an increase in the outcome
Lynch, John; Smith, George Davey; Hillemeier, Marianne; Shaw, Mary; Raghunathan, Trivellore; Kaplan, George	2001	Ecological	1990/1991	Country-level	Pearson correlations	Gini coefficient	Suicide	No significant association between income inequality and suicide	No	Income inequality was not associated with an increase in the outcome
Wilkins, Natalie J., Xinjian Zhang Karin A. Macka, Angela J. Clapperton, et al.	2019	Ecological	2011	Society-level	Poisson regression	Gini coefficient	Suicide	Inverse relationship between suicide and income inequality: higher income inequality associated with lower suicide rates	Yes	Income inequality was not associated with an increase in the outcome
Forati, Amir M., Ghose, Rina, Mantsch, John R.	2021	Ecological	1985 to 2015	Country-level, community-level	Ordinary least squares regression	Gini coefficient (this was only available upon request to authors)	Community-level drug overdose deaths rates	Inequality of household income was associated with increased risk of Opioid Overdose Deaths	Yes	Income inequality was associated with an increase in the outcome

*Citation: (Jackson, 1983)

Knowledge gaps and research aims

As outlined in the narrative synthesis outlined of the literature reviews, gaps in the literature may include: 1) lack of longitudinal studies investigating associations between income inequality and mental health related outcomes; 2) lack of studies on income inequality and mental health in youth, despite that income inequality affects all people of any age and that mental health conditions are typically onset during youth; 3) lack of studies that attempt to highlight the mechanisms by which income inequality may contribute to mental health (and specifically mental health in youth); 4) lack of empirical studies examining the potential associations between income inequality and deaths attributable to alcohol use, suicide, and drug overdose (again, also specifically not carried out among youth); and, 5) lack of studies using large population-based samples to ensure generalizability of findings regarding income inequality and mental health.

This thesis work generally hypothesizes that income inequality is associated with adverse mental health outcomes and increased risk for deaths attributable to suicide, drug overdose, and alcohol-related liver disease among young Canadians. Specifically, this thesis is composed of four articles addressing the following hypotheses:

1. Income inequality is associated with depression and anxiety over time in school-aged sample of adolescents;

2. Income inequality is associated with adolescent depression via psycho-social well-being and social cohesion;

3. The association between income inequality and adolescent depression and anxiety was amplified during COVID-19; and,

4. Income inequality in youth is associated with an increased risk of deaths of 'despair, or those deaths owing to suicide, drug overdose, and alcohol-related liver disease, over time.

Structure of the thesis

This thesis is comprised of an Introduction section (Chapter 1), four articles (Chapters 2 through 5, assessing objectives one through four), and a Concluding chapter (Chapter 6). The first article entitled "A longitudinal study of income inequality and mental health among Canadian secondary school students, results from the COMPASS Study (2016-2019)" has been accepted for publication to the Journal of Adolescent Health. This study set the foundation for two additional analyses, including one path analysis to identify some potential mediators in the association between income inequality and mental health and one longitudinal study to investigate how the association between income inequality and mental health has changed in light of the COVID-19 pandemic. The second article is entitled "Income inequality and depression among Canadian secondary students: Are psychosocial well-being and social cohesion mediating factors?" and has been published in the journal Social Sciences and Medicine: Public Health (Benny et al., 2022a). The third article is titled "Income inequality and mental health in adolescents during COVID-19, results from COMPASS 2018-2021", but has not been submitted or published in any peer-reviewed journals. The final article, titled "Investigating the association between income inequality in youth and deaths of despair in Canada, a population-based cohort study from 2006 to 2019" has been published in the Journal of Epidemiology and Community Health (Benny et al., 2022b). A brief overview of main findings, a discussion that synthesizes all four articles, future directions for research, and possible public health implications are presented following these four manuscripts.

Chapter 3, Article 1: A longitudinal study of income inequality and mental health among Canadian secondary school students, results from the COMPASS Study (2016-2019).

Claire Benny

Karen A. Patte

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Ambikaipakan Senthilselvan

Scott T. Leatherdale

Roman Pabayo

Abstract

Purpose. Depression and anxiety among adolescents are major public health concerns. Findings indicate income inequality was associated with increased risk for depression and anxiety among adolescents; however, this has not been tested longitudinally. We aim to quantify the longitudinal association between income inequality and depression and anxiety among Canadian adolescents.

Methods. We used longitudinal data on 21,141 students from three waves (2016/17 to 2018/19) of the Cannabis, Obesity, Mental health, Physical activity, Alcohol, Smoking, and Sedentary behaviour (COMPASS) school-based study. Multi-level modeling was used to assess the association between Census Division (CD)-level income inequality and depressive and anxiety symptoms and odds for depression and anxiety over time.

Results. Across CDs, the mean Gini coefficient was 0.37 (range: 0.30, 0.46). Attending schools in CDs with higher levels of income inequality was associated with higher depressive scores (ß = 0.08; 95% CI= 0.02, 0.14) and an increased odds for depression (OR= 1.55, 95% CI= 1.06, 2.28) over time. Income inequality was not significantly associated with anxiety symptoms or experiencing anxiety over time. Additional analyses showed that income inequality was associated with higher depressive scores among females (ß=0.10; 95% CI=0.01,0.18) and males (ß=0.08, 95% CI=0.01, 0.15) over time. The association between CD-level income inequality and anxiety scores was statistically significant among females (ß =0.13, 95% CI=0.04, 0.22), but not among males.

Conclusions. Findings from this study indicated that income inequality is associated with depression over time among adolescents. This study highlights key points of intervention for the prevention of mental illness in adolescents.

Introduction

Mental health is a major public health concern worldwide with incidence rates of mental disorders ranging from 2,456.2 per 100,000 in Myanmar to 8,752.1 per 100,000 in Greenland in 2019 (Global Burden of Disease, 2013). The incidence of depression and anxiety in Canada were estimated to be roughly 3,240 new cases per 100,000 people (Global Burden of Disease, 2013) and 633 new cases per 100,000 people in 2019, respectively (Canadian Mental Health Association, 2014); which is lower than neighbouring countries, such as the United States at 5,041.2 new cases per 100,000 and 802.2 new cases per 100,000 (Global Burden of Disease, 2013), respectively. Mental disorders are the second leading cause of years of healthy life lost and fifth leading cause of disability-adjusted life years in Canada (Global Burden of Disease, 2013). In Canada, specifically, the past 12 months prevalence and lifetime prevalence of depression are 4.7% and 11.2%, respectively (Knoll & MacLennan, 2017); while anxiety disorders affect 5% of the Canadian population. These illnesses are most common among young Canadians aged 15 to 24 years (Statistics Canada, 2013). The prevalence of past-year depression and anxiety fluctuates throughout the lifespan (Patten et al., 2015). Of note, cases of depression typically onset in adolescence and young adulthood, with those that onset in adolescence noted to be particularly severe should they persist throughout the lifespan (Wilson et al., 2015).

Experiencing mental health in youth may be especially difficult because the hormonal fluctuations associated with puberty, which differ from but may resemble some symptoms of mental illness (Thapar et al., 2012). As such, mental health problems may be less detectable among youth or may be excused as typical symptoms of puberty. In addition, the stigma associated with seeking help for mental health care is also highly prevalent in schools and other youth-centred environments (Aguirre Velasco et al., 2020; Radez et al., 2021). Complicated emotions associated

with mental health problems can manifest in feelings of mistrust, isolation, hopelessness, and disorder. These feelings may also make it more difficult for youth to seek treatment, which can worsen mental health (Richard G. Wilkinson, 1999). As a result, the large majority of youth mental health conditions go untreated or undetected (Children's Commisioner for England, 2016; Kutcher & Venn, 2008). Prevention and treatment of teen mental health is crucial and as such it is important to understand the contextual drivers of depression and anxiety in adolescents.

Contextual factors, such as social inequities, contribute to a person's health and mental health (Solar & Irwin, 2010). One example of social inequity is income inequality. Income inequality is most often measured using the Gini coefficient, which is a score between 0 and 1, with 1 indicating high inequality and 0 indicating perfect equality in incomes. In Canada, the Gini coefficient has been increasing since the late 1980s and early 1990s (Statistics Canada, 2020b), suggesting growing income inequality within the population. Between 1990 and 2018, there was a 5.9% increase in the average Gini coefficient across Canada (Statistics Canada, 2020b). Further, in the decade leading up to 2006, there was a 7.5% increase in the average Gini coefficient across Canadian Census Divisions (CDs) (Breau, 2014).

It is hypothesized that income inequality is associated with adverse mental health outcomes (V Patel et al., 2018). For example, studies from the United States have observed that state-level income inequality is associated with increased incidence of depression, albeit only among adult women (Pabayo et al., 2014). In adolescents, empirical research has indicated an association between higher income inequality and risk of mental health problems (Y. Kim & Hagquist, 2018; Rivenbark et al., 2019). Moreover, existing research does link higher income inequality to an increased risk of adolescent depression (Benny, Patte, et al., 2022; Sun et al., 2012), specifically among girls (Pabayo et al., 2016), and anxiety (Vilhjalmsdottir et al., 2018, 2019); with potential

mechanisms including decreased social cohesion and psychosocial-well-being associated with both higher income inequality and depressive symptoms (Benny, Patte, et al., 2022). Furthermore, adolescents may not be able to cope, or do not have the resources and support to cope with living in areas with high income inequality which may lead to an increased risk for depression and anxiety. However, the role of income inequality in adolescent mental health has not yet been tested longitudinally in the Canadian context. Most existing studies used self-reported mental health as a means of identifying mental illness among adolescents. Self-report measures can be unreliable due to reporting biases (e.g., social desirability bias, recall bias) (Grimm, 2010). Furthermore, most existing evidence is limited by cross-sectional designs as longitudinal research is necessary to better understand the temporal association between income inequality and adolescent mental health. To fill these gaps in the literature, the current study used a longitudinal approach to quantify the association between income inequality and mental health, using validated measures of depression and anxiety in a large cohort of Canadian secondary school students. We hypothesized that those students attending schools in higher income inequality areas would have higher risk of depression and anxiety in comparison to those attending schools in more equal areas.

Methods

Data source: COMPASS, 2016-2019

The sample of this study included 21,141 adolescents in grades 9 through 12 in British Columbia, Alberta, and Ontario, and those in Secondary I through V (the equivalent of grades 7 to 11) in Quebec, attending 75 secondary schools that participated in the Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking, and Sedentary behaviour (COMPASS) survey in the 2016/2017 academic year and were followed-up at least once in the 2017/18 and/or 2018/19 survey waves.

The COMPASS host study is a prospective cohort study (2012-2027) designed to collect hierarchical longitudinal data from a convenience sample of secondary schools in provinces across Canada (Leatherdale et al., 2014). The COMPASS study recruited schools that met board-approved inclusion criteria. Criteria included that the school had to be English-speaking, host students from grades 9 to 12, have at least 100 students per grade, and allow for the use of active-information passive-consent parental permission protocols (Leatherdale et al., 2014). Once annually, an in-class paper-and-pencil questionnaire is used to collect student-reported data on various health behaviours and outcomes from full school samples using active information, passive-consent protocols (Leatherdale et al., 2014). This study used data collected from 2016-2019 since mental health measures were implemented in 2016, and the following waves were impacted by the COVID-19 pandemic. Student-generated participant codes enabled individual-level data to be linked across waves. All procedures received ethics approval from the University of Waterloo (ORE#30118), Brock University (REB#18-099), CIUSSS de la Capitale-Nationale–Université Laval (#MP-13-2017-1264), and participating school boards.

COMPASS data were deterministically linked to the 2016 Canadian Census Health and Environment Cohort Profile (CanCHEC) to identify geographical information. Respondents in the COMPASS who were linked to the CanCHEC were then followed up in COMPASS until the 2018/2019 academic year. Details on the distribution of the student questionnaire over time are available in Appendix C, Supplementary Table C-1. Note despite some loss-to-follow-up, that characteristics of the sample remain consistent over time. Data from our sample in the 2016-2017 wave inform baseline characteristics on our sample as described in Table 3-1.

Measures

Exposure: Income inequality

The main exposure for this research was income inequality, measured using the Gini coefficient. The Gini coefficient was calculated using CanCHEC 2016 household income data in Census divisions (Statistics Canada, 2020b). Gini coefficient was measured by dividing the area between the Lorenz curve (i.e., the proportion of the total income of the population that is cumulatively earned by the lowest earners in the population) of the CD-level income distribution and the distribution line of incomes within an area by the area under the distribution line, with the Lorenz curve. Gini coefficient and the other CD-level variables were calculated based on the Census division of the school that each student attends. Continuous variables were standardized using the z-transformation.

Outcome measures: Adolescent depression and anxiety

Depression and anxiety were assessed using self-report measures that have demonstrated validity in adolescents, including measurement invariance by gender in the COMPASS survey (Romano et al., 2022). The 10-item Center for Epidemiologic Studies Depression scale Revised (CES-D) asked students how often they experience symptoms within the last 7 days (Andresen et al., 1994). Sum scores ranged from 0-30, with higher scores indicating greater depressive symptoms. The 7-item Generalized Anxiety Disorder scale (GAD-7) was used to evaluate anxiety scores by asking how often students experienced each symptom in the past two weeks (Spitzer et al., 2006). Continuous scores for each disorder were assessed using individual questions on the student's mental health. Sum scores ranged from 0-21, with higher scores indicating greater anxiety symptoms. Depression and anxiety scores were standardized using the z-transformation.

Dichotomous measures to indicate clinically relevant symptoms were also used. A meta-analysis of 28 validity studies of the CES-D demonstrated that the pooled sensitivity of the scale for measuring depression in the general population at a cut-off of 16 was 0.87, and the pooled specificity was 0.70 (Vilagut et al., 2016). At a cut-off score of 20, trade-offs are improved at 0.83 and 0.78, respectively (Vilagut et al., 2016), and so this cut-off was used instead to binarize students as being 'depressed' or 'not depressed'. At a cut-off of 10, the GAD-7 has a sensitivity of 0.89 and a specificity of 0.82 to identify probable cases of generalized anxiety disorder (Spitzer et al., 2006). Scores 10 or greater were coded as 'anxiety', and otherwise were coded as 'no anxiety'. Scales for each of mental health scales outlined in this work are detailed in Appendix C (Supplementary Document C-1 and C-2). The measurement and depressive and anxiety scores in the COMPASS study was found to be generalizable to other youth populations survey (Romano et al., 2022),

Covariates

Covariates were selected because they could potentially act as confounders in the relationship between income inequality and adolescent mental health. These confounders identified using the existing literature (Benny, Patte, et al., 2022).

Individual-level measures.

The final models adjusted for student-reported age, gender, race [Black, Hispanic, Asian, or other (selected 'other', multiple responses, or Métis, First Nations, or Inuit; ethics restrictions precluded the identification of students with Indigenous heritage for separate study)], and personal weekly spending money (in increments, as available in the COMPASS).

Census division-level measures.

CD-level measures across British Columbia, Alberta, Ontario, and Quebec were used. A census division (CD) is the general term for provincially legislated areas (such as county and regional district) or their equivalents (Statistics Canada, 2012). Models adjusted for year of study, median neighbourhood income, proportion of immigrant (in the past five years) households, and the proportion of lone-parent (i.e., single-parent) households in each CD across British Columbia, Alberta, Ontario, and Quebec.

Analytic technique: Three-level multi-level modelling

Three-level multi-level modelling was used to investigate the association between CD-level income inequality and each mental health outcome (depression score, depression anxiety score, anxiety) over time (level-1) while controlling for both individual (level-2) and area-level (level-3) characteristics. Multi-level models are commonly used when data are nested. For this investigation, repeated measures were clustered within students, who are clustered within CDs. Adjusting for clustering was necessary because individual's responses were not independent between school CD- levels and over time. Models were developed using a step-up method. First, an intercept-only model was fit to determine the Intraclass Correlation Coefficient (ICC) to quantify the proportion of variance in mental health outcomes explained at each level in each model. Next, bivariate, multi-level analyses helped to identify the unadjusted association between CD-level income inequality and the outcomes over time. After this, a full, adjusted model was fit. This model included both area-level and individual-level factors to determine the association between income inequality and adolescent mental health over time while controlling for relevant covariates.

We also tested the association between CD-level income inequality and adolescent depression and anxiety score stratified by gender (i.e., females and males). We first tested a cross-level interaction term between Gini coefficient and gender to determine if associations were heterogeneous across males and females. However, we stratified the analysis regardless of statistical significance owing to the conceptual gender differences in mental health and social environment (e.g., income inequality) (Rich et al., 1988).

Results

The COMPASS 2016-17 wave included 51,823 students in 75 schools across 43 CDs. Of these, 21,141 students participated in at least two waves of the survey and were included in our sample. Students were excluded from the analysis if they were not followed-up at least once in the study period (i.e., at least one response in 2017-18 or 2018-19). For example, students in grade 12 at baseline would likely graduate secondary school, and therefore would not be followed up over the study period (Battista et al., 2019; Qian et al., 2015). The majority of our sample identified as female (52.3%), white (73.3%), and had at least some weekly spending money (78.2%, with 21.8% having no spending money). The mean age of our sample was 14.9 [standard deviation (SD) = 1.0], the mean CD-level Gini coefficient 0.4 (range: 0.3, 0.5), and the median CD-level after tax household income was $61,952.44 (SD= $8,648.69). At baseline, 7.9% of students scored 20 or greater on the CESD, indicating an increased risk for depression, and 25.8% scored 10 or greater on the GAD-7, indicating an increased risk for anxiety. More descriptive information about our sample at baseline is available in Table 3-1.

According to the intercept-only linear mixed models for depressive scores, the intraclass correlations were 0.02 (95% CI = 0.02, 0.04) and 0.59 (95% CI= 0.58, 0.60) between CDs and students within CDs over time, respectively. The plausible range in values for the intercept-only

multi-level logistic model for depression was 0.02 (ranging from: 0.01 to 0.03) at the CD-level and 0.65 (ranging from 0.62 to 0.68) between students within CDs over time. Table 3-2 illustrates the unadjusted association between CD-level income inequality and adolescent depressive z-scores over time. Based on this model, a SD-unit increase in CD-level income inequality was associated with an increase in depressive scores over time (ß=0.12, 95% CI= 0.06, 0.18). When individual- and CD-level covariates were considered, CD-level income inequality remained associated with an increase in z-transformed adolescent depressive scores (ß=0.08; 95% CI = 0.02, 0.14). Table 3-3 shows that the unadjusted association between income inequality and depression was significant (OR=1.56, 95% CI=1.08, 2.25) and the adjusted analysis indicated higher income inequality associated with an increased odds of depression (OR= 1.55, 95% CI= 1.06, 2.28). Figure 3-1 provides a graphical illustration of the interaction between z-transformed Gini coefficient and time (in years) in adolescent depressive scores. This figure shows that a SD-unit increase in Gini coefficient is associated with a unit increase in depressive scores over time compared (i.e., lower income inequality).

Further, for the intercept-only multi-level models for anxiety scores, the intraclass correlations were 0.04 (95% CI=0.02, 0.06) and 0.61 (95% CI=0.60, 0.62) between CDs and students within CDs over time, respectively. The plausible range in values for the intercept-only multi-level logistic model for depressive scores was 0.04 (ranging from: 0.02 to 0.06) at the CD-level and 0.67 (ranging from 0.66 to 0.69) between students within CDs over time. As outlined in Table 3-4, the unadjusted association between CD-level income inequality and z-transformed adolescent anxiety scores over time indicated that an increase in CD-level income inequality was associated with a beta-increase of 0.11 in anxiety scores over time (95% CI=0.04, 0.18). When individual- and CD-level covariates were added, CD-level income inequality was not significantly

associated with a change in z-transformed adolescent anxiety scores (β =0.06; 95% CI= -0.01, 0.12). As shown in Table 3-5, higher income inequality was significantly associated with an increased odds of anxiety in the unadjusted (OR= 1.36, 95% CI=1.04, 1.76), but not in the adjusted analyses (OR=1.22, 95% CI=0.93, 1.62).

The results from the stratified analysis by gender for depressive scores are presented in Appendix B, Supplementary Table B-3. We observed that the unadjusted models explaining the association between CD-level income inequality and z-transformed depressive scores showed statistically significant associations among both females (β=0.13; 95% CI=0.05, 0.22) and males (β=0.11, 95% CI=0.04, 0.19) over time. In the adjusted analyses, the statistical significance remained among females (β=0.10; 95% CI=0.01,0.18) and males (β=0.08, 95% CI=0.01, 0.15) over time. For anxiety, the association between CD-level income inequality and z-transformed anxiety scores was statistically significant among females (unadjusted β =0.19, 95% CI=0.10, 0.27; adjusted β =0.13, 95% CI=0.04, 0.22), but not among males. The results from the stratified analysis by gender for anxiety scores are presented in Appendix B, Supplementary Table B-4.

Discussion

The current study demonstrated that there is a statistically significant association between baseline income inequality in the Census Division where a student goes to school and their likelihood of depression and anxiety over time. More specifically, our results indicated that students who attend schools in areas with higher levels of income inequality have greater depression symptoms and increased odds of clinically significant depression when compared to those who attend schools in lower income inequality areas over time. Income inequality in the school area is important, considering that most youth spend a large proportion of their waking hours in schools. Further, officials at the CD-level hold influence over the availability of

programs within schools. The results also showed that CD-level income inequality was significantly associated with anxiety over time, but only in females.

The current findings add to the existing literature, which generally shows an association between income inequality and adolescent mental health, depression, and anxiety (Benny, Patte, et al., 2022; Y. Kim & Hagquist, 2018; Pabayo et al., 2016; Rivenbark et al., 2019; Vilhjalmsdottir et al., 2018, 2019); albeit, only in cross-sectional studies. That said, our null findings for the association between income inequality and adolescent anxiety warrant further investigation. While the estimates were in the direction we expected (i.e., higher income inequality was associated with higher anxiety scores and increased odds of anxiety), the lack of statistical significance could be explained by lag effects. For example, some research has shown that the effects of income inequality and self-rated health and mortality do not fully peak until 12 and seven years later, respectively (Blakely et al., 2000; Zheng, 2012). Longitudinal studies with longer follow-up periods may help to improve the quality of this research.

This is the first study of its kind to quantify the association between income inequality and youth mental health, longitudinally. The current study used a large, school-based cohort study to evaluate the research question. Research has demonstrated that school-based studies provide important context, which is key to understanding the association between socio-economic inequalities and adolescent mental health (Goodman et al., 2003). Moreover, the current study strengthens the existing field of study with longitudinal evidence, given that the existing literature has only demonstrated that income inequality and mental health are associated in cross-sectional data. Further, the current study uses validated measures of depression and anxiety (i.e., the CES-D and GAD-7, respectively) and is the first to assess their association with income inequality in a longitudinal Canadian adolescent sample.

The current study can contribute to discussions on reducing income inequality (i.e., by increasing minimum wage, implementing cash transfer programs). A recent study demonstrated that minimum wage increases in the United States were associated with a 3.4% decrease in suicide rates in working-age adults (Kaufman et al., 2020). Findings from research using microsimulation techniques have also demonstrated that such programs are predicted to be associated with significant decreases in cases of depression in mothers (Benny, Yamamoto, et al., 2022). Further, some (albeit limited) evidence from lower- and middle-income countries has demonstrated that unconditional cash transfers have positive impacts on mental health in marginalized groups (Pega et al., 2022). Given that income inequality has been increasing in Canada over past decades and is unlikely to plateau and may be likely to increase due to the COVID-19 pandemic (Statistics Canada, 2020a), addressing income inequality is of the utmost importance. Further, these findings may help to identify some potential points of intervention for prevention and treatment programs for adolescents attending schools in areas with higher levels of income inequality.

Limitations

The results of the current study should be interpreted in the light of some important limitations. For example, the results of the current study may be prone to selection bias. This is because marginalized populations (e.g., people at risk for adverse mental health) are reportedly more likely to respond inaccurately to surveys or refuse to participate (Qian et al., 2015). It is also important to note that though full school samples and favourable response rates (>80% across the current study period) support generalizability, and the COMPASS system draws upon many schools across BC, Alberta, Ontario, and Quebec, it was not designed to be representative. Finally, recall bias is possible but limited in the study because youth are asked about their recall of feelings

in the past week (for depression) and past-two weeks (for anxiety). In addition, several sources of information bias must be considered in relation to the study design (Grimes & Schulz, 2002). For example, social desirability bias could occur in terms of responding to the COMPASS survey, especially for sensitive topics such as those regarding mental health concerns.

Moreover, in our sample there are cases where multiple secondary schools exist within single Census divisions, and so the actual level of variability in income inequality may not be fully realized in our study. Future research may use smaller geographical areas to quantify this association; however, it should be noted that officials within CDs have the authority to make policy decisions for that CD and so some programs for reducing income inequality or for targeting mental health problems may be made at this level. Additionally, researchers may consider stratifying analyses across key subgroups to determine if observed associations between income inequality and mental health outcomes are heterogeneous across groups. Another important limitation of the study is the potential for residual confounding, such as in household income. Existing studies report that lower earners are at a higher risk of mood disorders compared to higher earners (Lorant et al., 2003; Sareen et al., 2011); however, given that COMPASS does not collect information on students' household income we were unable to control for absolute income at the individual-level. Considering this limitation, the median household income at the CD-level was included in the models to account for absolute income.

Conclusion

The current study strengthens the claim that higher income inequality is deleterious for adolescent depression, longitudinally, and within a Canadian context. These results have implications for youth mental health, given that this research can inform discussions on targeting schools in higher income inequality areas for programs for improving adolescent mental health

outcomes. Future research should evaluate this association using quasi-experimental evidence to provide stronger support of the hypothesis. Overall, the study may lend to discussion on implications policy regarding income inequality, given that the findings demonstrate that income inequality is harmful for youth mental health.

<div align="center">References</div>

Aguirre Velasco, A., Cruz, I. S. S., Billings, J., Jimenez, M., & Rowe, S. (2020). What are the barriers, facilitators and interventions targeting help-seeking behaviours for common mental health problems in adolescents? A systematic review. *BMC Psychiatry*, *20*(1), 293. https://doi.org/10.1186/s12888-020-02659-0

Andresen, E. M., Malmgren, J. A., Carter, W. B., & Patrick, D. L. (1994). Screening for depression in well older adults: Evaluation of a short form of the CES-D. *American Journal of Preventive Medicine*, *10*(2), 77–84.

Benny, C., Patte, K. A., Veugelers, P., Leatherdale, S. T., & Pabayo, R. (2022). Income inequality and depression among Canadian secondary students: Are psychosocial well-being and social cohesion mediating factors? *SSM-Population Health*, *17*, 100994.

Blakely, T. A., Kennedy, B. P., Glass, R., & Kawachi, I. (2000). What is the lag time between income inequality and health status? *Journal of Epidemiology & Community Health*, *54*(4), 318–319.

Breau, S. (2014). L'inégalité des revenus au Canada. *Nouvelles Perspectives En Développement Régional: Essais En l'honneur de Donald J. Savoie*.

Canadian Mental Health Association. (2014). *Fast Facts about Mental Illness*.

Children's Commisioner for England. (2016). *Lightning Review: Access to Child and Adolescent Mental Health Services*.

Global Burden of Disease. (2013). GBD Compare. *Seattle: University of Washington*.

Goodman, E., Huang, B., Wade, T. J., & Kahn, R. S. (2003). A multilevel analysis of the relation
of socioeconomic status to adolescent depressive symptoms: does school context matter?
The Journal of Pediatrics, *143*(4), 451–456. https://doi.org/https://doi.org/10.1067/S0022-
3476(03)00456-6

Grimes, D. A., & Schulz, K. F. (2002). Bias and causal associations in observational research.
The Lancet, *359*(9302), 248–252. https://doi.org/10.1016/S0140-6736(02)07451-2

Grimm, P. (2010). Social Desirability Bias. In *Wiley International Encyclopedia of Marketing*.

Kim, Y., & Hagquist, C. (2018). Trends in adolescent mental health during economic upturns
and downturns: a multilevel analysis of Swedish data 1988-2008. *J Epidemiol Community
Health*, *72*(2), 101–108.

Knoll, A. D., & MacLennan, R. N. (2017). Prevalence and correlates of depression In Canada:
Findings from the Canadian Community Health Survey. *Canadian Psychology*, *58*(2), 116–
123. https://doi.org/=

Kutcher, S., & Venn, D. (2008). Why youth mental health is so important. *Medscape Journal of
Medicine*, *10*(12), 275. https://pubmed.ncbi.nlm.nih.gov/19242581

Leatherdale, S., Brown, K., Carson, V., Childs, R., Dubin, J., Elliot, S., Faulkner, G., Hammond,
D., Manske, S., Sabiston, C., Laxer, R., Bredin, C., & Thompson-Haile, A. (2014). The
COMPASS study: a longitudinal hierarchical research platform for evaluating natural
experiments related to changes in school-level programs, policies and built environment
resources. *BMC Public Health*, *14*, 331.

Lorant, V., Deliège, D., Eaton, W., Robert, A., Philippot, P., & Ansseau, M. (2003).
Socioeconomic inequalities in depression: a meta-analysis. *American Journal of*

Epidemiology, *157*(2), 98–112.

Pabayo, R., Dunn, E., Gilman, S., Kawachi, I., & Molnar, B. (2016). Income inequality within urban settings and depressive symptoms among adolescents. *J Epidemiol Community Health*, *70*(10), 997–1003.

Pabayo, R., Kawachi, I., & Gilman, S. (2014). Income inequality among American states and the incidence of major depression. *J Epidemiol Community Health*, *68*(2), 110–115.

Patel, V., Burns, J., Dhingra, M., Tarver, L., Kohrt, B., & Lund, C. (2018). Income inequality and depression: a systematic review and meta-analysis of the association and a scoping review of mechanisms. *World Psychiatry*, *17*(1), 76–89.

Patten, S. B., Williams, J. V. A., Lavorato, D. H., Wang, J. L., McDonald, K., & Bulloch, A. G. M. (2015). Descriptive epidemiology of major depressive disorder in Canada in 2012. *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie*, *60*(1), 23–30. https://doi.org/10.1177/070674371506000106

Qian, W., Battista, K., Bredin, C., Brown, K. S., & Leatherdale, S. T. (2015). Assessing longitudinal data linkage results in the COMPASS study. *Compass Technical Report Series*, *3*(4). https://uwaterloo.ca/compass-system/publications/assessing-longitudinal-data-linkage-results-compass-study

Radez, J., Reardon, T., Creswell, C., Lawrence, P. J., Evdoka-Burton, G., & Waite, P. (2021). Why do children and adolescents (not) seek and access professional help for their mental health problems? A systematic review of quantitative and qualitative studies. *European Child & Adolescent Psychiatry*, *30*(2), 183–211. https://doi.org/10.1007/s00787-019-01469-4

Rich, C. L., Ricketts, J. E., Fowler, R. C., & Young, D. (1988). Some differences between men

and women who commit suicide. *The American Journal of Psychiatry*.

Rivenbark, J. G., Copeland, W. E., Davisson, E. K., Gassman-Pines, A., Hoyle, R. H., Piontak, J. R., Russell, M. A., Skinner, A. T., & Odgers, C. L. (2019). Perceived social status and mental health among young adolescents: Evidence from Census data to cellphones. *Developmental Psychology*, *55*(3), 574.

Romano, I., Ferro, M. A., Patte, K. A., & Leatherdale, S. T. (2022). Measurement invariance of the GAD-7 and CESD-R-10 among adolescents in Canada. *Journal of Pediatric Psychology*, *47*(5), 585–594.

Sareen, J., Afifi, T. O., McMillan, K. A., & Asmundson, G. J. G. (2011). Relationship between household income and mental disorders. *Archives of General Psychiatry*, *68*(4), 419. https://doi.org/10.1001/archgenpsychiatry.2011.15

Solar, O., & Irwin, A. (2010). *A conceptual framework for action on the social determinants of health*. WHO Document Production Services.

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of Internal Medicine*, *166*(10), 1092–1097.

Statistics Canada. (2012). *Census division: Detailed definition*. Illustrated Glossary: 92-195-X. https://www150.statcan.gc.ca/n1/pub/92-195-x/2011001/geo/cd-dr/def-eng.htm

Statistics Canada. (2013). *Table 105-1101 Mental health profile, Canadian Community Health Survey - Mental Health (CCHS), by age group and sex, Canada and provinces*. CANSIM Tables.

Statistics Canada. (2020a). *Economic impacts and recovery related to the pandemic*. https://www150.statcan.gc.ca/n1/en/pub/11-631-x/2020004/s5-eng.htm

Statistics Canada. (2020b). *Table 11-10-0134-01 Gini coefficients of adjusted market, total and after-tax income*. Data.

Sun, P., Unger, J. B., Palmer, P., Ma, H., Xie, B., Sussman, S., & Johnson, C. A. (2012). Relative income inequality and selected health outcomes in urban Chinese youth. *Social Science & Medicine*, *74*(1), 84–91.

Thapar, A., Collishaw, S., Pine, D. S., & Thapar, A. K. (2012). Depression in adolescence. *Lancet (London, England)*, *379*(9820), 1056–1067. https://doi.org/10.1016/S0140-6736(11)60871-4

Vilagut, G., Forero, C. G., Barbaglia, G., & Alonso, J. (2016). Screening for Depression in the General Population with the Center for Epidemiologic Studies Depression (CES-D): A Systematic Review with Meta-Analysis. *PloS One*, *11*(5), e0155431–e0155431. https://doi.org/10.1371/journal.pone.0155431

Vilhjalmsdottir, A., Bernburg, J. G., Gardarsdottir, R. B., & Sigfusdottir, I. D. (2018). Community income inequality and adolescent emotional problems: A population-based study. *Journal of Community Psychology*, *46*(6), 715–733.

Vilhjalmsdottir, A., De Clercq, B., Gardarsdottir, R. B., Bernburg, J. G., & Sigfusdottir, I. D. (2019). Decreasing income inequality and adolescent emotional distress: a population-based case study of Icelandic adolescents 2006–2016. *International Journal of Public Health*, *64*(2), 253–263.

Wilkinson, R. G. (1999). Health, hierarchy, and social anxiety. *Annals of the New York Academy of Sciences*, *896*, 48–63. https://doi.org/10.1111/j.1749-6632.1999.tb08104.x

Wilson, S., Hicks, B. M., Foster, K. T., McGue, M., & Iacono, W. G. (2015). Age of onset and course of major depressive disorder: associations with psychosocial functioning outcomes

in adulthood. *Psychological Medicine*, *45*(3), 505–514.

https://doi.org/10.1017/S0033291714001640

Zheng, H. (2012). Do people die from income inequality of a decade ago? *Social Science &*

Medicine (1982), *75*(1), 36–45. https://doi.org/10.1016/j.socscimed.2012.02.042
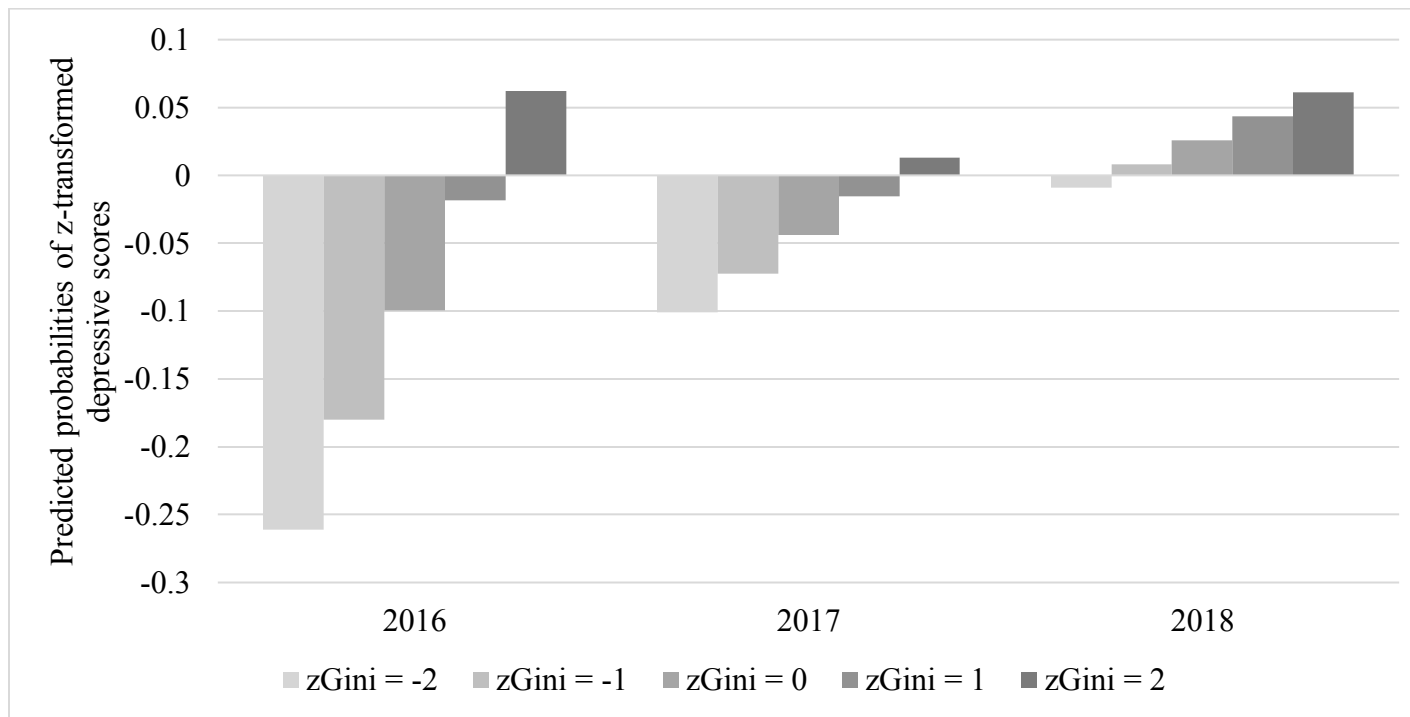
Figure 3-1. Graphical representation of the predicted probabilities of z-transformed depression scores and the interaction between z-transformed income inequality (zGini) values (-2 through 2) and time (in years), COMPASS 2016/17 to 2018/19.

Table 3-1. Distribution of the sample characteristics at baseline, COMPASS 2016/17.

Individual-level Characteristics

Variable		n	%
Gender	Female	10,979	52.29
	Male	10,016	47.71
Race/ethnicity	White	15,412	73.25
	Black	850	4.04
	Asian	1631	7.75
	Hispanic	713	3.39
	Other	2434	11.57
Weekly spending money	$0	3,878	21.77
	$1 to $5	1,590	8.93
	$6 to $10	1,882	10.57
	$11 to $20	3,173	17.81
	$21 to $40	2.480	13.92
	$41 to $100	2.359	13.23
	More than $100	2,450	13.75

	Mean (Min, Max)	Standard deviation
Age In years	14.94 (12, 19)	1.04
Depression score	9.02 (0, 30)	6.21
GAD-7 score	6.87 (0, 21)	5.97
CD-level Characteristics		
Gini coefficient	0.37 (0.30, 0.46)	0.021
Percentage of visible minority households	16.20% (0.59, 49.16%)	9.77%
Percentage of lone-parent households	15.74% (10.22, 22.41%) 1.59% (0.10, 5.9%)	2.23% 1.10%
Percentage of recent immigrant households		
Median household income	$61,952 (49,203-87,183)	$8,468.69

Table 3-2. Results from the unadjusted and adjusted models for the association between CD-level income inequality and z-transformed adolescent depression score, COMPASS 2016/17-2018/19.

		Unadjusted model				Adjusted model			
			95 % CI				95 % CI		
		ß	Lower bound	Upper bound	p-value	ß	Lower bound	Upper bound	p-value
CD-level z-transformed Gini coefficient (zGini)		0.12	0.06	0.18	<0.001	0.08	0.02	0.14	0.009
Year of study	2017/2018 (ref: 2016)	0.09	0.05	0.13	<0.001	0.06	0.01	0.10	0.012
	2018/2019	0.23	0.19	0.26	<0.001	0.13	0.08	0.17	<0.001
Time trend	2017-18*zGini	-0.04	-0.08	0.01	0.119	-0.05	-0.11	0.00	0.052
	2018-19*zGini	-0.05	-0.10	-0.01	0.029	-0.06	-0.12	-0.01	0.018
CD-level									
% of visible minority households						-0.02	-0.08	0.04	0.530
% of lone-parent households						0.05	0.02	0.07	<0.001
% of recent immigrant households						-0.01	-0.08	0.05	0.678
Median household income						0.05	0.02	0.07	<0.001
Individual-level									
Gender	Male (ref: female)					-0.44	-0.46	-0.42	<0.001
Race/ethnicity	Black (ref: non-white)					0.01	-0.04	0.06	0.778
	Asian					0.07	0.04	0.11	<0.001
	Hispanic					0.06	0.01	0.12	0.018
	Other					0.12	0.09	0.15	<0.001
	$1 to $5 (ref: $0)					-0.02	-0.05	0.02	0.307

Weekly spending money	$6 to $10					-0.03	-0.07	0.00	0.036
	$11 to $20					-0.07	-0.10	-0.04	<0.001
	$21 to $40					-0.08	-0.10	-0.05	<0.001
	$41 to $100					-0.06	-0.09	-0.03	<0.001
	More than $100					-0.05	-0.08	-0.02	<0.001
Age	In years					0.07	0.06	0.07	<0.001
Intercept		-0.19	-0.25	-0.14	<0.001	-0.88	-1.01	-0.76	<0.001

Table 3-3. Results from the unadjusted and adjusted models for the association between CD-level income inequality and z-transformed

adolescent depression, COMPASS 2016/17-2018/19.

		Unadjusted model				Adjusted model			
			95 % CI				95 % CI		
		OR	Lower bound	Upper bound	p-value	OR	Lower bound	Upper bound	p-value
CD-level z-transformed Gini coefficient (zGini)		1.56	1.08	2.25	0.017	1.55	1.06	2.28	0.024
Year of study	2017/2018 (ref: 2016)	1.05	0.78	1.41	0.737	0.93	0.68	1.27	0.630
	2018/2019	1.49	1.11	2.00	0.007	1.14	0.83	1.56	0.429
Time trend	2017-18*zGini	0.81	0.57	1.14	0.219	0.72	0.50	1.04	0.077
	2018-19*zGini	0.74	0.52	1.04	0.082	0.66	0.46	0.95	0.026
CD-level									
% of visible minority households						0.95	0.76	1.20	0.679
% of lone-parent households						1.12	1.00	1.25	0.048
% of recent immigrant households						0.89	0.68	1.15	0.366
Median household income						1.17	1.06	1.30	0.002
Individual-level									
Gender	Male (ref: female)					0.22	0.19	0.25	<0.001
Race/eth nicity	Black (ref: non-white)					0.81	0.59	1.13	0.211
	Asian					0.98	0.79	1.20	0.819
	Hispanic					1.16	0.85	1.58	0.349
	Other					1.52	1.28	1.81	<0.001
	$1 to $5 (ref: $0)					0.75	0.60	0.94	0.013

Weekly spending money	$6 to $10					0.72	0.58	0.90	0.003
	$11 to $20					0.63	0.52	0.75	<0.001
	$21 to $40					0.59	0.49	0.72	<0.001
	$41 to $100					0.66	0.55	0.79	<0.001
	More than $100					0.79	0.67	0.93	0.005
Age	In years					1.16	1.10	1.22	<0.001
Intercept		0.01	0.01	0.01	<0.001	0.00	0.00	0.01	<0.001

Table 3-4. Results from the unadjusted and adjusted models for the association between CD-level income inequality and z-transformed adolescent anxiety score, COMPASS 2016/17-2018/19.

		Unadjusted model				**Adjusted model**			
			95 % CI				95 % CI		
		ß	Lower bound	Upper bound	p-value	ß	Lower bound	Upper bound	p-value
CD-level z-transformed Gini coefficient (zGini)		0.11	0.04	0.17	0.001	0.06	-0.01	0.12	0.083
Year of study	2017/2018 (ref: 2016)	0.06	0.03	0.10	0.001	0.03	-0.01	0.07	0.174
	2018/2019	0.16	0.13	0.20	<0.001	0.06	0.02	0.11	<0.001
Time trend	2017-18*zGini	-0.03	-0.07	0.02	0.229	-0.04	-0.09	0.01	0.106
	2018-19*zGini	-0.04	-0.08	0.01	0.118	-0.04	-0.09	0.01	0.079
									CD-level
% of visible minority households						-0.03	-0.11	0.04	0.375
% of lone-parent households						0.07	0.03	0.11	<0.001
% of recent immigrant households						0.01	-0.08	0.09	0.875
Median household income						0.07	0.04	0.11	<0.001
									Individual-level
Gender	Male (ref: female)					-0.56	-0.58	-0.54	<0.001
Race/ethnicity	Black (ref: non-white)					-0.13	-0.18	-0.08	<0.001
	Asian					-0.05	-0.08	-0.01	0.008
	Hispanic					0.00	-0.05	0.05	0.932
	Other					0.07	0.04	0.10	<0.001
	$1 to $5 (ref: $0)					0.01	-0.02	0.04	0.588

Weekly spending money	$6 to $10					-0.02	-0.05	0.01	0.127
	$11 to $20					-0.05	-0.07	-0.02	<0.001
	$21 to $40					-0.06	-0.09	-0.03	<0.001
	$41 to $100					-0.02	-0.05	0.00	0.080
	More than $100					0.01	-0.02	0.03	0.666
Age	In years					0.06	0.06	0.07	<0.001
Intercept		-0.15	-0.22	-0.08	<0.001	-0.75	-0.88	-0.63	<0.001

Table 3-5. Results from the unadjusted and adjusted models for the association between CD-level income inequality and z-transformed adolescent anxiety, COMPASS 2016/17-2018/19.

		Unadjusted model				**Adjusted model**			
			95 % CI				95 % CI		
		OR	Lower bound	Upper bound	p-value	OR	Lower bound	Upper bound	p-value
CD-level z-transformed Gini coefficient (zGini)		1.36	1.04	1.76	0.023	1.22	0.93	1.62	0.154
Year of study	2017/2018 (ref: 2016)	1.10	0.92	1.32	0.301	1.00	0.82	1.21	0.999
	2018/2019	1.53	1.28	1.83	<0.001	1.13	0.92	1.37	0.236
Time trend	2017-18*zGini	0.95	0.76	1.18	0.635	0.88	0.70	1.12	0.309
	2018-19*zGini	0.88	0.71	1.10	0.264	0.83	0.66	1.05	0.124
CD-level									
% of visible minority households						0.88	0.66	1.17	0.393
% of lone-parent households						1.28	1.12	1.46	<0.001
% of recent immigrant households						1.03	0.75	1.41	0.868
Median household income						1.31	1.15	1.49	<0.001
Individual-level									
Gender	Male (ref: female)					0.16	0.15	0.18	<0.001
Race/ethnicity	Black (ref: non-white)					0.63	0.51	0.78	<0.001
	Asian					0.85	0.73	0.97	0.020
	Hispanic					0.93	0.76	1.16	0.533
	Other					1.33	1.18	1.50	<0.001
	$1 to $5 (ref: $0)					0.92	0.79	1.06	0.239

Weekly spending money	$6 to $10					0.82	0.72	0.94	0.005
	$11 to $20					0.77	0.69	0.87	<0.001
	$21 to $40					0.75	0.67	0.85	<0.001
	$41 to $100					0.87	0.77	0.98	0.018
	More than $100					0.97	0.86	1.08	0.545
Age	In years					1.23	1.19	1.28	<0.001
Intercept		0.06	0.05	0.08	<0.001	0.01	0.01	0.02	<0.001

Chapter 4, Article 2: Income inequality and depression among Canadian secondary students: Are psychosocial well-being and social cohesion mediating factors?.

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ABSTRACT

Background. Nearly one-third of secondary school students report experiencing depressive symptoms in the past year. Existing research suggests that increasing rates of depression are due in part to increasing income inequality. The aim of this study is to identify mechanisms by which income inequality contributes to depression among Canadian secondary school students.

Methods. We used data from the 2017/18 wave of the Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking, and Sedentary behaviour (COMPASS) study among a large sample of Canadian secondary school students. The sample included 61,642 students across 43 Census divisions (CDs) in Quebec, Ontario, Alberta and British Columbia. We used multi-level path analysis to determine if the relationship between CD-level income inequality and depression was mediated by student's psychosocial well-being and/or social cohesion.

Results. Attending schools in CDs with higher income inequality was related to higher depression scores among Canadian secondary students [unstandardized ß (β) = 5.36; 95% CI = 0.74, 9.99] and lower psychosocial well-being (β = -14.83, 95% CI = -25.05, -4.60). Income inequality was not significantly associated with social cohesion, although social cohesion was associated with depression scores among students (β = -0.31; 95% CI = -0.34, -0.28).

Discussion. Findings from this study indicate that income inequality is associated with adolescent depression and that this relationship is mediated by psychosocial well-being. This study is the first of its kind in Canada to assess the mechanisms by which income inequality contributes to adolescent depression. These findings are applicable to school-level programs addressing mental health.

Keywords: income inequality, mental health, adolescent mental health, mediation

1.1 Introduction

Mental illnesses are a collection of disorders characterized by their impact on cognitive,

behavioural, and emotion regulation functions (American Psychiatric Association, 2013;

McIntyre et al., 2013), with the most prevalent being mood disorders (Whiteford et al., 2013).

Depression is one of the most common mental illnesses in Canada, affecting roughly 8% of

Canadians at some point throughout the lifespan (Canadian Mental Health Association, 2014),

and is most common among Canadians aged 15 to 24 years (Statistics Canada, 2013). Indeed,

mental health among adolescents is a major public health concern. School-based studies have

shown that 28.5% of adolescents report experiencing depression symptoms, such as feeling sad

or hopeless, in the previous 12 months. Moreover, the probability of having experienced

depression in adolescence ranges from approximately 5% (Costello et al., 2005) to 20% with

increasing age (P M Lewinsohn et al., 1999). Depression is also, at times, less detectable in

adolescents in comparison to their older counterparts. This is because the hormonal fluctuations

associated with puberty often results in negative affect and angst, which are different, but may

resemble some symptoms of depression (Thapar et al., 2012). Additionally, young people may

be more vulnerable to depression as they navigate increasingly complex social environments,

which have shown to be significant predictors of mental health (NCCS for Environmental Health

and Determinants of Health, 2001).

Income inequality is a contextual factor that represents the disproportionate distribution

of income within a given group or area, and is increasingly recognized as a key social

determinant of health (Pabayo et al., 2016). Canada experienced a 5.9% increase in income

inequality since 1990 with Gini coefficients increasing from 0.286 to 0.303 in 2018 (Statistics

Canada, 2020b). A common measure of income inequality within an area is the Gini coefficient,

which ranges from 0 (low income inequality) to 1 (high income inequality). For example, in the decade leading up to 2006, there was a 7.5% increase in income inequality across Canadian Census divisions (Breau, 2014). The significant increases in income inequality across Canada present an urgent need to investigate their impact in light of the putative association of income inequality with depression (Statistics Canada, 2020b).

The relationship between income inequality and health is best conceptualized using the income inequality hypothesis (Rodgers, 1979). This hypothesis posits that an individual's level of income influences a person's health by the distribution of incomes in the area in which they live (Rodgers, 1979). Several empirical studies investigated the association between income inequality and adverse mental health outcomes (Heflin & Iceland, 2009; Lund et al., 2010; Marshall et al., 2005; Ridley et al., 2020) and, specifically, depression (Fan et al., 2011; Masselink et al., 2018). Among adolescents, income inequality within residential neighbourhoods was shown to be associated with increased depressive symptoms among girls, but not boys, in the United States (Pabayo et al., 2016). Given the rising levels of income inequality and self-reported adolescent depression in Canadian society (Breau, 2014; Statistics Canada, 2020b), it is critically important to understand the role of income inequality on adolescent depression in Canada.

With respect to adolescent populations, the school is an contextual environment for consideration when discussing adolescent mental health as most adolescents tend to spend most of their waking hours in schools (Abrams et al., 2005). Research has previously demonstrated the school-level characteristics are important for adolescent mental health (Goodman et al., 2003). In addition, the high school experience might be an especially challenging time for students, who may experience stress due to puberty, as well as academic and social pressures

(Pascoe et al., 2020). As such, studying the effect of income inequities within school environments is crucially important.

2.1 Theory

The current study draws on two of the main mechanisms proposed by Kawachi and colleagues (1999). Existing studies highlight two potential mechanisms that explain the relationship between income inequality and depression. First, the literature demonstrates that people who live in areas with vastly different incomes than their peers may face feelings of shame and worsened psychosocial well-being due to their living conditions (Wilkinson & Pickett, 2006), with psychosocial well-being operationally defined as a person's positive affect [collectively influenced by, for example, their satisfaction with life, self-esteem, and ability to succeed (Patte et al., 2017)]. Coined the "theory of social comparison", these feelings may, in turn, manifest in symptoms of depression (I Kawachi & Kennedy, 1999). Second, exposure to polarized incomes may lead people to feel segregated from their peers and mistrust in their community or social groups, thus eroding social cohesion, or feelings of trust, acceptance/rejection, and tolerance between members of society (Buttrick & Oishi, 2017; I Kawachi & Kennedy, 1999; Moody & White, 1999). Those experiencing worsened social cohesion may develop depressive symptoms because they feel isolated and disconnected from their peers.

Declines in psychosocial well-being and social cohesion may synergistically or independently contribute to the risk of depression (Akhtar-Danesh & Landeen, 2007; I Kawachi & Kennedy, 1999). These same mechanisms could be identified among adolescents; however, limited research exists that explains the relationship between income inequality and depression among adolescents. For example, in a study of 15- and 16-year-old adolescents from Iceland,

researchers investigated the role of social capital as a mediator between income inequality and adolescent emotional distress and found that while higher levels of income inequality were associated with increased emotional distress, social capital was not a mediating factor (Vilhjalmsdottir et al., 2016). Also, Pabayo et al, (2016) found no evidence that social cohesion mediated the relationship between neighborhood income inequality and depressive symptoms among adolescents living in Boston, Massachusetts. Nonetheless, we wanted to see if social cohesion acted as a mediator between income inequality and depressive symptoms in a Canadian setting.

3.1 Methods

3.1.1 Data: COMPASS, 2017/2018

Data were taken from the Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking, and Sedentary behaviour (COMPASS) school survey, which is a prospective cohort study (2012-2021) containing hierarchical data from adolescents in grades 9 through 12 from more than 120 schools in British Columbia, Alberta, Ontario, and Quebec (Leatherdale et al., 2014). For this investigation, we completed a cross-sectional analysis among those who participated in Wave 6 (2017-2018).

The overall objective of COMPASS was to collect health-related information from students attending a convenience sample of secondary schools. An in-class, pen-to-paper questionnaire was administered to collect student reported data on behaviours, mental and physical health, school connectedness, and academic outcomes. COMPASS also annually collects data from school administrators and staff who are knowledgeable about the school environment. All students attending participating schools were invited to participate using active-information passive- consent parental permission protocols (Leatherdale et al., 2014), which are

critical for collecting robust youth mental health data [Further details of COMPASS methods are available online (www.compass.uwaterloo.ca) or in print (Leatherdale et al., 2014)]. The current study utilized the Student Questionnaire component of the COMPASS, which was deterministically linked to the 2016 Canadian Census Health and Environment Cohort Profile (CanCHEC) by Census division (CD) (Tjepkema et al., 2019).

3.1.2   Ethics

The research team completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2) certification requirement to access and disseminate the COMPASS data. The current study was approved by the University of Alberta IRB, the University of Waterloo Research Ethics Board (ORE 30118), as well as all participating school board review panels.

3.1.3 Measures

3.1.3.1 Exposure measure: Income inequality

We used the Gini coefficient to measure income inequality at the CD-level using the 2016 Canada Census. The calculation of the Gini coefficient has been described elsewhere (Left Business Observer, 1993). CD-level income inequality was deterministically linked (Zhu et al., 2015) to the COMPASS data using each students' postal code. Z-transformed Gini coefficient were used in the standardized path models.

3.1.3.2 Outcome measure: Depressive symptoms

The study outcome was adolescent depression, measured using the 10-item Center for Epidemiologic Studies Depression Scale revised (CES-D). The CES-D is a validated scale in the COMPASS used to identify potential cases of adolescent depression (Herge et al., 2013). A higher score on the CES-D is indicative of a greater number of depressive symptoms and,

therefore, a higher likelihood of adolescent depression (Herge et al., 2013). Z-transformed depression scores were used in the standardized path models.

3.1.3.3 Mediating variables

We identified individual-level measures based on the existing literature and the availability of data in the COMPASS. The COMPASS contains validated scales on psychosocial well-being [e.g., the Flourishing Scale (Patte et al., 2017), a scale for measuring student well-being and self-esteem] and school connectedness, which will serve as a proxy for social cohesion in adolescence. The flourishing scale has been previously validated amongst adult populations and confirmatory factor analysis by the COMPASS group suggests that use of the flourishing scale is valid for use in adolescents (Romano et al., 2020). The COMPASS uses a school connectedness scale that encompasses a number of Likert scaled statements in the COMPASS, with students evaluating constructs such as "I am a good person and live a good life", "I am optimistic about my future", and, "people respect me". Similarly, school connectedness was measured using Likert scales with statements such as "I feel close to people at my school" and "I feel I am a part of my school". Scales for each of mental health scales outlined in this work are detailed in Appendix C (Supplementary Documents C-1 and C-3).

3.1.3.4 Covariates

We controlled for the proportion of lone parent households, proportion of low-income households, and the proportion of visible minority households at the CD-level and gender, age, and ethnicity at the individual-level to account for potential confounding in the modelling procedures. Gender was self-reported in the COMPASS, with students reporting that they identify as "male", "female", or "other". Ethnicity was measured in the compass by asking

students if they identify as White, Black, Asian, Latin, or Other. We then categorized ethnicity into a dichotomous variable, with students identifying as "white" or "non-white".

3.1.4 Statistical analysis: Multilevel path analysis

3.1.4.1 Model overview

The data were examined using histograms to check the normality assumption of each variable, correlations to check the bivariate relationships between variables, and frequencies to describe the relevant characteristics of the sample. We fitted an intercept-only model to calculate the Intraclass Correlation Coefficient (ICC), which allowed us to quantify the proportion of variance in depression explained at the individual- and CD-levels. A statistically significant (*p*-value < 0.05) ICC value indicated that a clustered model was necessary.

Our study used nested data (individuals nested within CDs), because the exposure, income inequality was measured at the CD-level (i.e., Level 2), and our mediating and outcome variables were measured at the individual-level (i.e., Level 1). As such, it was important to account for between-level indirect effects. This analysis was described as a multi-level path analysis, which tests the indirect effects of CD-level income inequality on adolescents' mental health outcomes via social cohesion and psychosocial well-being. These multi-level path analyses were conducted using Stata IC v16.0. The paths proposed in the current study are illustrated in Figure 4-1. We report both standardized and unstandardized coefficients. This allowed us to draw direct comparisons on the strength of associations (via standardized coefficients) and interpret the results based on the raw data and scales (via unstandardized coefficients).

3.1.4.1 Assessing goodness of fit of the model

We assessed the model fit using the X^2 test, in conjunction with the comparative fit index, Tucker-Lewis Index and the Root Mean Square Error of Approximation (RMSEA) test. With a sample size of 61,642, using the comparative fit test and Tucker-Lewis Index, an estimate of less than 0.95 was appropriate for identifying acceptable model fit; and, using the RMSEA, an estimate of less than 0.8 was deemed an acceptable model fit (Hu & Bentler, 1999).

The individual-level model had X^2 value that demonstrated that there were significant differences between groups and, as such, a poor model fit. However, existing evidence suggested that the X^2 test is heavily influenced by sample size (DiLalla, 2000), so we tested model fit using alternative methods. RMSEA, CFI, and TLI tests indicated that the path modelled in this study was well fit with values of 0.00, 1.00, and 1.00, respectively. At the CD-level, the X^2 test also indicated poor fit. Using the same reasoning, we tested the RMSEA, CFI, and TLI which indicated good model fit with values of 0.000, 1.000, and 1.000, respectively.

4.1 Results

4.1.1 Descriptive statistics

Characteristics of the 61,642 students attending the 124 schools from 43 Census divisions are presented in Table 4-1. The sample included near equal parts male and female participants (49.6% and 49.5%, respectively). Most participants were between the ages of 15 and 16 (24.2% and 23.7%, respectively). Nearly three-quarters of the sample identified as being white (72.5%). The mean Gini coefficient at the CD-level was 0.37 (SD=0.025; range=0.30 to 0.46). Correlations among study variables are presented in Tables 4-2 and 4-3.

The intraclass coefficient (ICC) demonstrated that there was significant variation in depression between the individual- and CD-levels (ICC=0.030, $p < 0.001$). The ICC indicates that 3.0% of the total variance in depression score is explained at the CD-level.

4.1.2 Path Analysis

We were initially interested in the paths proposed in Figure 4-1 (see Methods), but local and global fit testing indicated that the proposed model was not well fit (X^2 p-value = < .001; CFI = 0.517; RMSEA = 0.656; and TLI = -1.897). The modification indices suggested that including covariance between psychosocial well-being and social cohesion was an appropriate way to improve model fit. Conceptually, social cohesion should be associated with psychosocial well-being (Cameron & Stinson, 2017). Our revised model had improved fit. Figure 4-2 illustrates the standardized coefficients for the direct and indirect paths in the revised, well-fit model.

An analysis of the relationship between income inequality and depression demonstrated that a one-standard deviation (SD) increase in Gini coefficient was associated with a significant increase in depression score [unstandardized regression coefficient (β) = 5.36; 95% CI = 0.74, 9.99] when adjusting for percentage of lone parent households, percentage low-income households, and percentage visible minority households at the CD-level and gender at the individual-level. The results from the mediated, adjusted path demonstrated that a one-SD increase in Gini coefficient was also significantly associated with a 14.82 reduction in psychosocial well-being score (95% CI = -25.02, -4.63); however, the Gini coefficient was not significantly associated with a change in social cohesion score (β =-2.86; 95% CI -8.29, 2.57). Additionally, a one-SD increase in social cohesion was significantly associated with a reduction in depression scores (β =-0.31; 95% CI=-0.34, -0.28); and a one-SD increase in psychosocial well-being score was associated with a reduction in depression scores (β =-0.50; 95% CI = -0.52,

-0.47). As per the revised model, social cohesion was significantly associated with psychosocial well-being (β =11.58; 95% CI=10.65, 12.52). The results of this path analysis are described in full detail in Table 4-4.

Based on the standardized results, we see that the strongest associations were between psychosocial well-being and depression (β = -0.47; 95% CI=-0.49, -0.45), social cohesion and depression (β = -0.17; 95% CI=-0.19, -0.16), and CD-level income inequality and psychosocial well-being (β = -0.07; 95% CI=-0.11, -0.02). The standardized results from this path analysis are available in Table 4-5.

5.1 Discussion

This study examined some mechanisms by which income inequality contributed to depression outcomes among adolescents. Our results align with the literature that proposed income inequality may affect psychosocial well-being, which may have deleterious effects on adolescent mental health (Pabayo et al., 2016; Vilhjalmsdottir et al., 2016). We accounted for these mediating variables by looking at psychosocial well-being, which is highly related to feelings of shame, and school-connectedness, which served as a proxy for social cohesion within the school environment. The current study demonstrated that CD-level income inequality was associated with depression among Canadian post-secondary students and that this relationship was also mediated by psychosocial well-being. This means that, among some adolescents, the association between income inequality and depression was affected by the students' level of psychosocial well-being. The results indicate that students who live in areas with high levels of income inequality and low psychosocial well-being scores were more likely to have higher depression scores than their counterparts with higher psychosocial well-being scores. Unsurprisingly, we found that psychosocial well-being and social cohesion were highly related

in our research. Finally, the Gini coefficient appeared inversely associated with psychosocial well-being and social cohesion, aligning with the literature that found a higher level of income inequality is typically associated with decreases in psychosocial well-being and social cohesion (Coburn, 2000; Jahan et al., 2015; Osborne et al., 2015; Wilkinson, 1997).

The mechanism by which income inequality contributes to adolescent depression is likely affected by several mediating variables. Those identified in the existing literature include feelings of inferiority and superiority (R. Wilkinson & Pickett, 2017), feelings of despise and humiliation (Walker et al., 2013), feelings of social isolation (R. Wilkinson & Pickett, 2017), feelings of mistrust (I Kawachi & Kennedy, 1999), and feelings of dominance and subordination (Johnson et al., 2012; Wilkinson & Pickett, 2017). These items can be grouped into two overarching constructs: social cohesion (e.g., feelings of mistrust) and psychosocial well-being (e.g., self-esteem and feelings of inferiority, superiority, despise, humiliation, dominance, and subordination). The existing literature has also demonstrated that there is an indirect relationship between income inequality and adverse mental health that was mediated by feelings of shame and eroded social cohesion (Akhtar-Danesh & Landeen, 2007; Buttrick & Oishi, 2017; V Patel et al., 2018). However, these relationships had never been tested among adolescents.

Consistent with the existing literature (Vilhjalmsdottir et al., 2016), we were unable to identify social cohesion as a significant mediator between income inequality and depression. However, we would like to note that the direction of the association between income inequality and social cohesion was as hypothesized, with higher levels of income inequality being associated with lower levels of social cohesion. The lack of statistically significant findings could also be explained by the idea that social cohesion differentially affects socio-demographic groups. Social cohesion, community and school participation, or social inclusion is equally

beneficial to adolescent mental health in differing socio-demographic groups (Jenson, 1998). For example, some research demonstrates that social cohesion is experienced differently by different racial groups, potentially owing to discrimination, which may increase isolation, thereby reducing social cohesion in some people and groups (Reitz et al., 2009; Reitz & Banerjee, 2007). Nonetheless, the current study provides some evidentiary support of the link between income inequality and depression is primary through psychosocial well-being and not through social cohesion.

Additionally, this study provided evidence in support of the income inequality hypothesis, as it identified an independent relationship between income inequality and adolescent depression. A key takeaway from the income inequality hypothesis is that increases in inequality can lead to feelings of low self-esteem, which contributes to the risk of poor psychosocial well-being and subsequent poor mental health (Akhtar-Danesh & Landeen, 2007; Buttrick & Oishi, 2017). This principle is echoed in the current research, considering that not only was CD-level income inequality associated with depression, but it was also associated through poor psychosocial well-being, which may worsen in adolescents as a result of polarization or segregation (Pijl et al., 2011).

5.1.1 Strengths

Despite these limitations, the current study offers several strengths. This study is the first of its kind using Canadian data to evaluate the paths by which income inequality in an adolescent's CD contributes to adolescent health. This is important because adolescents tend to spend most of their waking hours in schools (Abrams et al., 2005), and existing evidence shows that school-based studies are important in the study of income inequality and adolescent mental health (Goodman et al., 2003). Additionally, the current study uses a national survey of Canadian

adolescents with a large sample size to evaluate its research question. As such, the study may be generalizable to other similarly distributed student populations in Canada. Furthermore, the study used a validated measure for identifying depressive symptoms and cases of depression in the study sample.

5.1.2 Limitations

Some evidence has argued against the use of multi-level structural equation modelling (SEM), such as multilevel path analysis, when the number of clusters is less than 100 (McNeish, 2017; McNeish & Stapleton, 2016). Methodologists propose the use of multiple multi-level models may be a more appropriate method given that with too few clusters (McNeish, 2017), estimates are often biased toward the null and standard error coefficients, thereby reduced, resulting in an increased likelihood of Type I error (Maas & Hox, 2005). Additionally, the current study used cross-sectional data to assess the research question. As such, we were not able to infer temporality nor a causal relationship between income inequality and depression based on our study results. The lagged impacts of income inequality may be a contributing reason as to why the relationship between income inequality and social cohesion was not statistically significant in the current study.

It is also important to note that there is a possibility of residual confounding in this study. Covariates were selected based on the existing literature, and those that were available in the COMPASS system were included in the modelling. Unfortunately, the COMPASS system does not include information on some important risk factors for depression, including adverse childhood experience, physiological comorbidities, vulnerability, nor cumulative stress over the lifespan. Such factors are reported to have significant effects on mental health among teens

(Goldstein et al., 2015; Hughes et al., 2017; Masarik & Conger, 2017; Nishikawa et al., 2018; Rottenberg et al., 2014) and should be addressed in future research.

The results of the current study may be subject to selection bias. This is because marginalized populations, such as illicit drug users, are less likely to respond truthfully or at all to surveys (Johnson, 2014; Qian et al., 2015). More specifically, students who have mental health problems or engage in substance use behaviours may be less likely to respond to the COMPASS, as attendance rates are lower in these samples and students may not have been present for the pen-to-paper survey (Qian et al., 2015). It is also important to note that while the COMPASS system draws upon a large number of schools across BC, Alberta, Ontario, and Quebec, no survey weights exist to develop a population-based dataset and so the findings of this work may have limited generalizability to larger populations. However, it is likely that the results could be applied to schools with similar social environments.

There is, of course, a possibility that the relationship between income inequality and depression, as well as relationships between social cohesion, psychosocial well-being, and depression, exist due to other mechanisms beyond the scope of this paper. For example, access to mental health services may be an important mediator to consider in future research considering that the existing literature has demonstrated that an association exists between access to mental health services and depression in adolescents (Masselink et al., 2018; Skrove et al., 2013; Werner-Seidler et al., 2017); and, conceptually, area-level income inequality could impact a person's ability to access mental health services. Additionally, some research suggests that social cohesion within social groups varies greatly across socio-economic groups (Copeland et al., 2018; Schiefer & Van der Noll, 2017). Future research should explore additional mediating factors in their research by testing the effects of social cohesion independently across

socioeconomic groups, and evaluate natural experiments (e.g., increases in minimum wage, cash transfers).

6.1 Conclusions

The current research confirms for the Canadian setting that income inequality is harmful for adolescent mental health, both in terms of psychosocial well-being and depressive symptoms. The results have important implications, with youth mental health promotion and mental illness prevention identified as public health priorities and schools are key context for interventions. Additionally, the study is novel as very few studies have investigated the role of income inequality among secondary school students, nor the pathways by which this determinant contributes to adolescent mental health. Psychosocial well-being, but not social cohesion, might mediate the relationship between income inequality and depression. However, social cohesion was significantly associated with higher depressive symptoms. Further investigations should utilize longitudinal data to gain a better understanding of mechanisms. Interventions targeting social cohesion and psychosocial well-being in schools may reduce the burden of adolescent depression and promoting psychosocial wellbeing. Additionally, the study may have broader policy and upstream implications as it provides evidence-based findings on the harmful effects of income inequality for policymakers, the scientific community, and the general public.

References

Abrams, K., Theberge, S. K., & Karan, O. C. (2005). Children and adolescents who are

    depressed: An ecological approach. *Professional School Counseling*, *8*(3), 282–292.

Akhtar-Danesh, N., & Landeen, J. (2007). Relation between depression and sociodemographic

    factors. *International Journal of Mental Health Systems*, *1*, 1–9.

    https://doi.org/10.1186/1752-4458-1-4

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders*

    (DSM-5®). American Psychiatric Pub.

Breau, S. (2014). L'inégalité des revenus au Canada. *Nouvelles Perspectives En Développement*

    Régional: Essais En l'honneur de Donald J. Savoie.

Buttrick, N., & Oishi, S. (2017). The psychological consequences of income inequality. *Soc Pers*

    Psychol Compass, *11*, e12304.

Cameron, J. J., & Stinson, D. A. (2017). *Encyclopedia of Personality and Individual Differences*

    (V. Zeigler-Hill & T. K. Shackelford (eds.); pp. 1–6). Springer International Publishing.

    https://doi.org/10.1007/978-3-319-28099-8_1187-1

Canadian Mental Health Association. (2014). *Fast Facts about Mental Illness*.

Coburn, D. (2000). Income inequality, social cohesion and the health status of populations: the

    role of neo-liberalism. *Social Science & Medicine*, *51*(1), 135–146.

Copeland, M., Fisher, J. C., Moody, J., & Feinberg, M. E. (2018). Different Kinds of Lonely:

    Dimensions of Isolation and Substance Use in Adolescence. *Journal of Youth and*

    Adolescence, *47*(8), 1755–1770. https://doi.org/10.1007/s10964-018-0860-3

Costello, E. J., Egger, H., & Angold, A. (2005). 10-year research update review: the

    epidemiology of child and adolescent psychiatric disorders: I. Methods and public health

burden. *Journal of the American Academy of Child and Adolescent Psychiatry*, *44*(10), 972–986. https://doi.org/10.1097/01.chi.0000172552.41596.6f

DiLalla, L. F. (2000). Structural equation modeling: Uses and issues. In *Handbook of applied multivariate statistics and mathematical modeling* (pp. 439–464). Elsevier.

Fan, A. Z., Strasser, S., Zhang, X., Dhingra, S., Mcknight-eily, L., Holt, J., & Balluz, L. (2011). State-level socioeconomic factors are associated with current depression among U . S . adults in 2006 and 2008. *Journal of Public Health and Epidemiology*, *3*(10), 462–470. http://www.academicjournals.org/JPHE

Goldstein, B. I., Carnethon, M. R., Matthews, K. A., McIntyre, R. S., Miller, G. E., Raghuveer, G., Stoney, C. M., Wasiak, H., & McCrindle, B. W. (2015). Major Depressive Disorder and Bipolar Disorder Predispose Youth to Accelerated Atherosclerosis and Early Cardiovascular Disease: A Scientific Statement From the American Heart Association. *Circulation*, *132*(10), 965–986. https://doi.org/10.1161/CIR.0000000000000229

Goodman, E., Huang, B., Wade, T. J., & Kahn, R. S. (2003). A multilevel analysis of the relation of socioeconomic status to adolescent depressive symptoms: does school context matter? *The Journal of Pediatrics*, *143*(4), 451–456. https://doi.org/https://doi.org/10.1067/S0022-3476(03)00456-6

Heflin, C. M., & Iceland, J. (2009). Poverty, material hardship, and depression. *Social Science Quarterly*, *90*(5), 1051–1071.

Herge, W. M., Landoll, R. R., & La Greca, A. M. (2013). *Center for Epidemiologic Studies Depression Scale (CES-D) BT - Encyclopedia of Behavioral Medicine* (M. D. Gellman & J. R. Turner (eds.); pp. 366–367). Springer New York. https://doi.org/10.1007/978-1-4419-1005-9_732

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hughes, K., Bellis, M. A., Hardcastle, K. A., Sethi, D., Butchart, A., Mikton, C., Jones, L., & Dunne, M. P. (2017). The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *The Lancet Public Health*, *2*(8), e356–e366.

Jahan, A., Tyagi, N., & Suri, S. (2015). Income disparity as a predictor of happiness and self-esteem. *The International Journal of Indian Psychology*, *3*(1), 149–156.

Jenson, J. (1998). *Mapping social cohesion: The state of Canadian research*. Canadian policy research networks Ottawa.

Johnson, S. L., Leedom, L. J., & Muhtadie, L. (2012). The dominance behavioral system and psychopathology: Evidence from self-report, observational, and biological studies. *Psychological Bulletin*, *138*(4), 692.

Johnson, T. P. (2014). Sources of Error in Substance Use Prevalence Surveys. *International Scholarly Research Notices*, *2014*, 1–21. https://doi.org/10.1155/2014/923290

Kawachi, I., & Kennedy, B. (1999). Income inequality and health: pathways and mechanisms. *Health Services Research*, *34*(1 pt 2), 215–227.

Leatherdale, S., Brown, K., Carson, V., Childs, R., Dubin, J., Elliot, S., Faulkner, G., Hammond, D., Manske, S., Sabiston, C., Laxer, R., Bredin, C., & Thompson-Haile, A. (2014). The COMPASS study: a longitudinal hierarchical research platform for evaluating natural experiments related to changes in school-level programs, policies and built environment resources. *BMC Public Health*, *14*, 331.

Left Business Observer. (1993). *Gini says: measuring income inequality*.

Lewinsohn, P. M., Rohde, P., Klein, D. N., & Seeley, J. R. (1999). Natural course of adolescent

    major depressive disorder: I. Continuity into young adulthood. *Journal of the American*

    Academy of Child and Adolescent Psychiatry, *38*(1), 56–63.

    https://doi.org/10.1097/00004583-199901000-00020

Lund, C., Breen, A., Flisher, A. J., Kakuma, R., Corrigall, J., Joska, J. A., Swartz, L., & Patel, V.

    (2010). Poverty and common mental disorders in low and middle income countries: A

    systematic review. *Social Science & Medicine*, *71*(3), 517–528.

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling.

    Methodology, *1*(3), 86–92.

Marshall, S. K., Charles, G., Hare, J., Jr, P. J. J., & Stokl, M. (2005). Sheway's services for

    substance using pregnant and parenting women: evaluating the outcomes for infants.

    Canadian Journal of Community Mental Health, *24*(1), 19–34.

Masarik, A. S., & Conger, R. D. (2017). Stress and child development: A review of the Family

    Stress Model. *Current Opinion in Psychology*, *13*, 85–90.

Masselink, M., Van Roekel, E., & Oldehinkel, A. J. (2018). Self-esteem in early adolescence as

    predictor of depressive symptoms in late adolescence and early adulthood: the mediating

    role of motivational and social factors. *Journal of Youth and Adolescence*, *47*(5), 932–946.

McIntyre, R. S., Cha, D. S., Soczynska, J. K., Woldeyohannes, H. O., Gallaugher, L. A.,

    Kudlow, P., Alsuwaidan, M., & Baskaran, A. (2013). Cognitive deficits and functional

    outcomes in major depressive disorder: determinants, substrates, and treatment

    interventions. *Depression and Anxiety*, *30*(6), 515–527.

McNeish, D. (2017). Multilevel Mediation With Small Samples: A Cautionary Note on the

    Multilevel Structural Equation Modeling Framework. *Structural Equation Modeling: A*

Multidisciplinary Journal, *24*(4), 609–625. https://doi.org/10.1080/10705511.2017.1280797

McNeish, D. M., & Stapleton, L. M. (2016). The effect of small sample size on two-level model estimates: A review and illustration. *Educational Psychology Review*, *28*(2), 295–314.

Moody, J., & White, D. R. (1999). *Social Cohesion and Embeddedness: A hierarchical conception of social groups*. unpublished manuscript, submitted to the AJS.

NCCS for Environmental Health and Determinants of Health. (2001). Environmental Influences on Population Mental Health Promotion for Children and Youth. In *Schulz & Northridge*. http://nccph.ca/images/uploads/general/03_Environmental_MentalHealth_NCCPH_2017_EN.pdf

Nishikawa, S., Fujisawa, T. X., Kojima, M., & Tomoda, A. (2018). Type and timing of negative life events are associated with adolescent depression. *Frontiers in Psychiatry*, *9*, 41.

Osborne, D., Sibley, C. G., & Sengupta, N. K. (2015). Income and neighbourhood-level inequality predict self-esteem and ethnic identity centrality through individual-and group-based relative deprivation: A multilevel path analysis. *European Journal of Social Psychology*, *45*(3), 368–377.

Pabayo, R., Dunn, E., Gilman, S., Kawachi, I., & Molnar, B. (2016). Income inequality within urban settings and depressive symptoms among adolescents. *J Epidemiol Community Health*, *70*(10), 997–1003.

Pascoe, M. C., Hetrick, S. E., & Parker, A. G. (2020). The impact of stress on students in secondary school and higher education. *International Journal of Adolescence and Youth*, *25*(1), 104–112. https://doi.org/10.1080/02673843.2019.1596823

Patel, V., Burns, J., Dhingra, M., Tarver, L., Kohrt, B., & Lund, C. (2018). Income inequality and depression: a systematic review and meta-analysis of the association and a scoping

review of mechanisms. *World Psychiatry*, *17*(1), 76–89.

Patte, K. A., Bredin, C., Henderson, J., Elton-Marshall, T., Faulkner, G., Sabiston, C., Ferro, M.,
Battista, K., & Leatherdale, S. T. (2017). *Development of a mental health module for the
COMPASS system: improving youth mental health trajectories. Part 1: Draft Development
and Design*. Compass Technical Report Series. University of Waterloo.
https://uwaterloo.ca/compass-system/development-mental-health-module-compass-system-
improving

Pijl, S. J., Frostad, P., & Mjaavatn, P.-E. (2011). Segregation in the classroom: What does it take
to be accepted as a friend? *Social Psychology of Education*, *14*(1), 41–55.

Qian, W., Battista, K., Bredin, C., Brown, K. S., & Leatherdale, S. T. (2015). Assessing
longitudinal data linkage results in the COMPASS study. *Compass Technical Report Series*,
3(4). https://uwaterloo.ca/compass-system/publications/assessing-longitudinal-data-linkage-
results-compass-study

Reitz, J. G., & Banerjee, R. (2007). *Racial inequality, social cohesion and policy issues in
Canada*. Citeseer.

Reitz, J. G., Breton, R., Dion, K. K., & Dion, K. L. (2009). *Multiculturalism and social
cohesion: Potentials and challenges of diversity*. Springer Science & Business Media.

Ridley, M. W., Rao, G., Schilbach, F., & Patel, V. H. (2020). *Poverty, Depression, and Anxiety:
Causal Evidence and Mechanisms*. National Bureau of Economic Research.

Rodgers, G. B. (1979). Income and inequality as determinants of mortality: an international
cross-section analysis. *Population Studies*, *33*(3), 343–351.
https://doi.org/10.1093/ije/31.3.533

Rottenberg, J., Yaroslavsky, I., Carney, R. M., Freedland, K. E., George, C. J., Baji, I., Dochnal,

R., Gádoros, J., Halas, K., Kapornai, K., Kiss, E., Osváth, V., Varga, H., Vetró, A., &

Kovacs, M. (2014). The association between major depressive disorder in childhood and

risk factors for cardiovascular disease in adolescence. *Psychosomatic Medicine*, *76*(2),

122–127. https://doi.org/10.1097/PSY.0000000000000028

Schiefer, D., & Van der Noll, J. (2017). The essentials of social cohesion: A literature review.

Social Indicators Research, *132*(2), 579–603.

Skrove, M., Romundstad, P., & Indredavik, M. S. (2013). Resilience, lifestyle and symptoms of

anxiety and depression in adolescence: the Young-HUNT study. *Social Psychiatry and

Psychiatric Epidemiology*, *48*(3), 407–416.

Statistics Canada. (2013). *Table 105-1101 Mental health profile, Canadian Community Health

Survey - Mental Health (CCHS), by age group and sex, Canada and provinces*. CANSIM

Tables.

Statistics Canada. (2020). *Table 11-10-0134-01 Gini coefficients of adjusted market, total and

after-tax income*. Data.

Thapar, A., Collishaw, S., Pine, D. S., & Thapar, A. K. (2012). Depression in adolescence.

Lancet (London, England), *379*(9820), 1056–1067. https://doi.org/10.1016/S0140-

6736(11)60871-4

Tjepkema, M., Christidis, T., Bushnik, T., & Pinault, L. (2019). Cohort profile: The Canadian

Census Health and Environment Cohorts (CanCHECs). *Health Reports*, *30*(12), 18–26.

Vilhjalmsdottir, A., Gardarsdottir, R. B., Bernburg, J. G., & Sigfusdottir, I. D. (2016).

Neighborhood income inequality, social capital and emotional distress among adolescents:

A population-based study. *Journal of Adolescence*, *51*, 92–102.

Walker, R., Kyomuhendo, G. B., Chase, E., Choudhry, S., Gubrium, E. K., Nicola, J. Y.,

Lødemel, I., Mathew, L., Mwiine, A., & Pellissery, S. (2013). Poverty in global perspective: is shame a common denominator? *Journal of Social Policy*, *42*, 215.

Werner-Seidler, A., Perry, Y., Calear, A. L., Newby, J. M., & Christensen, H. (2017). School-based depression and anxiety prevention programs for young people: A systematic review and meta-analysis. *Clinical Psychology Review*, *51*, 30–47.

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., Charlson, F. J., Norman, R. E., Flaxman, A. D., & Johns, N. (2013). Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*, *382*(9904), 1575–1586.

Wilkinson, R. G. (1997). Comment: income, inequality, and social cohesion. *American Journal of Public Health*, *87*(9), 1504–1506.

Wilkinson, R. G., & Pickett, K. E. (2006). Income inequality and population health: a review and explanation of the evidence. *Social Science & Medicine*, *62*(7), 1768–1784.

Wilkinson, R., & Pickett, K. (2017). Inequality and mental illness. *The Lancet Psychiatry*, *4*(7), 512–513.

Zhu, Y., Matsuyama, Y., Ohashi, Y., & Setoguchi, S. (2015). When to conduct probabilistic linkage vs. deterministic linkage? A simulation study. *Journal of Biomedical Informatics*, *56*, 80–86.
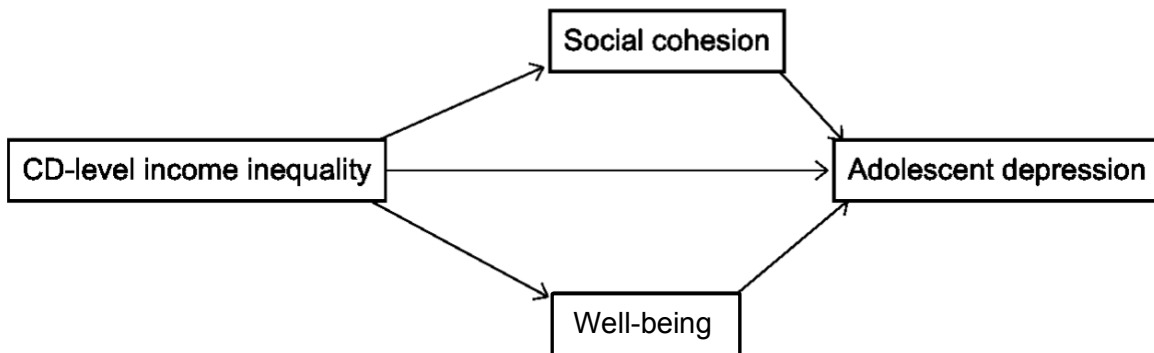
Figure 4-1. Diagram illustrating the proposed structural relationship between income inequality and adolescent depression.

Control variables:
-% lone parent households at CD level
-% visible minority households at CD level
-Student's gender at individual level
-Student's ethnicity at individual level
-Student's age at individual level

Social cohesion

ε

CD-level income inequality
(measured using Gini coefficient)

-2.86

-0.31***

5.36*

11.58***

Adolescent depression
(measured using CES-D)

ε

-14.82**

-0.50***

Psychosocial well-being

ε

CD-level fit indices:
X2= 334.27 (p<0.05)
RMSEA= 0.038
CFI= 0.995
TLI= 0.998

Individual-level fit indices:
X2= 26852.64 (p<0.05)
RMSEA= 0.000
CFI= 1.000
TLI= 1.000

CD-level

Individual-level

›* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Figure 4-2. Path diagram and unstandardized coefficients of the revised multi-level path analysis between CD-level income inequality and adolescent depression as mediated by social cohesion and psychosocial well-being, COMPASS (2017-2018).

Table 4-1. Table demonstrating the distribution of characteristics of the sample at the individual- and CD-levels, COMPASS (2017-2018).

Individual-level Characteristics			
Variable		n	%
Gender	Female	32,886	49.48
	Male	32,986	49.64
	Other or not listed	582	0.88
Ethnicity	White	48,148	72.45
	Non-white	18,306	27.55
		Mean (Min, Max)	Standard deviation
Age	In years	15.35 (12, 19)	1.43
Depression score		8.70 (0, 30)	6.03
Social cohesion score		18.32 (6, 24)	3.40
Psychosocial well-being score		31.94 (8, 40)	3.74
CD-level Characteristics			
Gini coefficient		0.37 (0.30, 0.46)	0.03
Percentage of visible minority households		13.58% (0.59, 49.16%)	14.7%
Percentage of lone-parent households		15.80% (10.22, 22.41%)	2.16%
Percentage of low-income households		7.73% (1.17, 13.94%)	3.13%

Table 4-2. Table of correlations between the model variables at the individual level, COMPASS (2017-2018).

	1	2	3	4
1. Gender	1.000			
2. Social cohesion	0.044*	1.000		
3. Psychosocial well-being	0.047*	0.059*	1.000	
4. Depression	-0.189	-0.464*	-0.586*	1.000

* = $p < 0.001$

Table 4-3. Table of correlations between the model variables at the CD-level, COMPASS (2017-2018).

	1	2	3	4
1. Income inequality	1.000			
2. % visible minority households	0.683*	1.000		
3. % lone-parent households	0.251*	-0.157*	1.000	
4. % low-income households	0.774*	0.741*	0.221*	1.000

* = $p < 0.001$

Table 4-4. Table of unstandardized multi-level path analysis results, COMPASS (2017-2018).

Outcome	Predictors	Coefficient (β)	*p*-value	95% CI (lower-bound)	95% CI (upper-bound)
Social cohesion	Gini coefficient	-2.86	0.301	-8.29	2.57
Psychosocial well-being	Gini coefficient	-14.82	0.004	-25.02	-4.63
Depression	Social cohesion	-0.31	< 0.001	-0.34	-0.28
	Psychosocial well-being	-0.50	< 0.001	-0.52	-0.47
	Gini coefficient	5.36	0.023	0.74	9.99
	Gender (female)	-1.89	<0.001	-1.98	-1.80
	Age (years)	0.18	<0.001	0.14	0.22
	Ethnicity (White)	-0.03	0.734	-0.19	0.13
Gini coefficient	% lone parent households in the CD	0.10	0.419	-0.14	0.34
	% visible minority households in the CD	0.04	<0.309	-0.04	0.12
	% low-income households in the CD	0.46	0.027	0.05	0.87
Social cohesion * Psychosocial well-being		11.58	< 0.001	10.65	12.52

Table 4-5. Table of standardized results from multi-level path analysis, COMPASS (2017-2018).

Outcome	Predictors	Coefficient (β)	p-value	95% CI (lower-bound)	95% CI (upper-bound)
Social cohesion	Gini coefficient	-0.02	0.301	-0.06	0.02
Psychosocial well-being	Gini coefficient	-0.07	0.004	-0.11	-0.02
Depression	Social cohesion	-0.17	< 0.001	-0.19	-0.16
	Psychosocial well-being	-0.47	< 0.001	-0.49	-0.45
	Gini coefficient	0.02	0.023	0.003	0.04
	Gender (female)	-0.16	0.734	-0.17	-0.15
	Age (years)	0.04	<0.001	0.03	0.05
	Ethnicity (White)	-0.002	0.734	-0.01	0.01
Gini coefficient	% lone parent households in the CD	0.00	0.419	-0.12	0.29
	% visible minority households in the CD	0.25	0.309	-0.23	0.72
	% low-income households in the CD	0.57	0.027	0.06	1.08
Social cohesion * Psychosocial well-being		0.59	< 0.001	0.55	0.64

Chapter 5, Article 3: Income inequality and mental health in adolescents during COVID-19, results from COMPASS 2018-2021.

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Abstract

Introduction. Understanding and mitigating potential adverse and inequitable impacts of the ongoing COVID-19 pandemic on youth mental health are leading priorities. Existing research has linked income inequality in schools to adolescent depression, however, it is unclear if the onset of the pandemic exacerbated the effects of income inequality on adolescent mental health. The current study aimed to quantify the relationship between income inequality and adolescent mental health during the COVID-19 pandemic.

Methods. Longitudinal data were taken from the three waves (2018/19 to 2020/21) of the Cannabis, Obesity, Mental health, Physical activity, Alcohol, Smoking, and Sedentary behaviour (COMPASS) school-based study. Growth Curve modelling was used to assess the relationship between Census District (CD)-level income inequality and depressive symptoms before and after the onset of COVID-19. Income inequality was assessed using CD-level Gini coefficient and adolescent depressive and anxiety scores were assessed using the 10-item Center for Epidemiologic Studies Depression Scale (CES-D) and General Anxiety Disorder-7 scale(GAD-7), respectively.

Results. The study sample included 29,722 students across 43 Census divisions in British Columbia, Alberta, Ontario, and Quebec. The average age of the sample at baseline was 14.9 years [standard deviation (SD)= 1.5] and ranged between 12 and 19 years of age. Most of the sample self-reported as white (76.3%), female (54.4%), and had weekly spending money of over $100 (20.9%). The mean Gini coefficient at the CD-level was 0.37 (SD=0.03). Students who completed the COMPASS survey after the onset of COVID reported 0.20-unit higher depressive scores (95% CI=0.16, 0.24) compared to pre-COVID. The adjusted analyses indicated that the relationship between income inequality on anxiety scores was significantly strengthened following the onset

of COVID-19 (β=0.02, 95% CI=0.0004, 0.03), indicating that income inequality was associated with a greater increase in anxiety scores during COVID-19, as compared to before COVID-19.

Discussion. The adjusted results indicate that the association between income inequality and adolescent anxiety persisted and was heightened at the onset of the COVID-19 pandemic. Future studies should use quasi-experimental methods to strengthen this claim. The current study can inform policy and program discussions regarding the effects of the COVID-19 pandemic on young Canadians and relevant social policies for improving adolescent mental health.

Introduction

The onset of the coronavirus 2019 (i.e., COVID-19) pandemic has adversely affected population mental health worldwide (Robinson et al., 2022), including the mental health of Canadian youth. Youth reported the largest reductions in mental health as a result of COVID-19 compared to any other age group in Canada, with 41.5% indicating they had excellent or very good perceived mental health in 2020, compared to 62.1% pre-pandemic in 2018 (StatsCAN Plus, 2022). Further, 57% of adolescents report that their mental health has worsened since the onset of school closures and "lockdowns" (StatsCAN Plus, 2022). School closures and lockdowns were likely associated with feelings of loneliness or social isolation, which can contribute to adolescents' risk of poor mental health (Stephenson, 2021). While, initially, early public health measures in Ontario reduced mental health out-patient visits in adolescents drastically in March/April of 2020 due to lockdowns and a shift to online services, usage of physician-based mental health services rose to above pre-COVID rates as of July 2020 and remained at this level until at least February 2021 (Saunders et al., 2022). Emergency department visits among adolescents for mental health-related services also increased in Canada as a result of the pandemic by as much as 29.7% (Chadi et al., 2021). Further, results from social media surveys demonstrated increased self-reported mental health problems in Canadian adolescents as a result of the pandemic (Craig et al., 2022).

The effects of the COVID-19 pandemic may have also widened the gap between the highest and lowest earners (i.e., income inequality) in Canada, with increases in unemployment rates disproportionately affecting the lowest earners, those less educated, immigrants, and those with precarious employment (Statistics Canada, 2020a) but have also been subsequently reducing owing to the Canadian Emergency Response Benefit (CERB) and the Canadian

Emergency Student Benefit (CESB), two programs employed during COVID-19 to mitigate financial losses. Income inequality refers to the relative differences in incomes within a given group or area (Left Business Observer, 1993). A wide gap in incomes is suggestive of a greater inequality in income, while a narrow gap suggests that there is not a wide distribution of incomes within a given group or area. In public health research, income inequality is most often measured using the Gini coefficient (De Maio, 2007). In Canada, the Gini coefficient has been increasing since the late 1980s and early 1990s (Breau, 2014; Statistics Canada, 2020b), especially in major urban centres (Abedi, 2017). For example, between 1990 and 2018, there was a 5.9% increase in the national Gini coefficient average in Canada (Statistics Canada, 2020b).

The multitude of stressors associated with the COVID-19 pandemic may have led to diminished mental health among adolescents, and the effects are likely more pronounced in those from socioeconomically disadvantaged areas. The pandemic, including related increases in income inequality associated with job loss and loss of wages in the pandemic (Statistics Canada, 2020a), may have left adolescents more vulnerable to adverse mental health. This supposition is in line with current theories on the relationship between income inequality and mental health. For example, income inequality is associated with increased divestment in human capital (e.g., cuts to social spending), which has been common in COVID-19. In turn, such divestments are associated with worsened mental health, given human capital sectors are oftentimes those that can improve health (Scheffler et al., 2010). Moreover, income inequality is associated with reductions in social cohesion, which was amplified during the COVID-19 pandemic. With the onset of lockdowns and work-from-home orders, adolescents grew increasingly isolated during the pandemic. This isolation is, in turn, may have been associated with poorer mental health.

While existing research has linked income inequality in schools to adolescent depression (Benny, Patte, et al., 2022), it is unclear if the onset of the pandemic exacerbated the association between income inequality and adolescent mental health. We hypothesize that the onset of the COVID-19 pandemic worsened the mental health of Canadian secondary school students. The objective of this study is to examine if the onset of COVID-19 exacerbated the association between income inequality and adolescent depression and anxiety.

Methods

Data source: COMPASS, 2018-2021

The sample of this study included 29,722 adolescents (i.e., those in grades 9 through 12) in 129 schools and 43 Census divisions (CDs) in British Columbia, Alberta, and Ontario, and those in grades 7 to 11 in Quebec who participated in the Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking, and Sedentary behaviour (COMPASS) survey in the 2018/2019 academic year and responded at least once in the 2019/20 and 2020/21 survey waves. COMPASS is a prospective cohort study (2012-2027), which was designed to annually collect hierarchical longitudinal data from a convenience sample of secondary schools (Leatherdale et al., 2014). The in-class questionnaire uses active information passive consent protocols and collects student reported data related to behaviours, health, school connectedness, and academic outcomes (Leatherdale et al., 2014).

The current study used longitudinal data collected from 2018/19 to 2020/21. The data were deterministically linked to the 2016 Canadian Census Health and Environment Cohort Profile (CanCHEC) to identify Census division (CD)-level information. All procedures received ethics approval from the University of Waterloo (ORE#30118), Brock University (REB#18-099),

University of Alberta (#RES0050375), CIUSSS de la Capitale-Nationale–Université Laval (#MP-13-2017-1264), and participating school boards.

Details on the number of student responses and to the Student Questionnaire and distribution of the original sample from 2018/2019 to 2020/2021 are available in Appendix C, Supplementary Table C-2. Despite a large reduction (51.6%) in number of responses, the distributions of characteristics in the unweighted sample remain similar over time.

Measures

Exposure: Income inequality

The main exposure for this research was income inequality, measured using the Gini coefficient. The Gini coefficient is expressed a score between 0 and 1, with 1 indicating high inequality and 0 indicating perfect equality in incomes. The Gini coefficient was calculated using CanCHEC 2016 after-tax household income data in CDs. Gini coefficient calculations involve dividing the area between the Lorenz curve (i.e., the proportion of the total income of the population that is cumulatively earned by the lowest earners in the population) of an income distribution and the distribution line of incomes within an area by the area under the distribution line of the Lorenz curve (Tjepkema et al., 2019). Gini coefficient was z-transformed to improve interpretability.

Outcome measures: Adolescent depressive and anxiety symptoms

Depressive and anxiety symptoms were assessed using self-report measures that have demonstrated validity in adolescents (Haroz et al., 2014; Mossman et al., 2017; Tiirikainen et al., 2019), and measurement invariance by gender specifically in the COMPASS survey (Romano et al., 2022). The 10-item Center for Epidemiologic Studies Depression scale Revised (CES-D) asked students how often they experience symptoms within the last 7 days (Andresen et al., 1994) and

the 7-item Generalized Anxiety Disorder scale (GAD-7) was used to capture anxiety scores by asking how often students experienced each symptom in the past two weeks (Spitzer et al., 2006). For example, the item "Please indicate how often the following statements apply to you: I felt depressed", was used to calculate a continuous depression score; whereas an item such as "Over the last 2 weeks, how often have you been bothered by the following problems? Feeling nervous, anxious, or on edge", was used to calculate a continuous anxiety score. Measures of depression and anxiety were standardized using the z-transformation.

Time: COVID-19

Those observations recorded prior to the March 2020 school closures associated with COVID-19 were coded as "pre-COVID-19" [time(T)1], and those following school closures and in the 2020/2021 wave were coded as "peri-COVID-19" (i.e., "during" COVID-19; T2).

Covariates

Individual-level measures.

The models adjusted for age (in years), gender (male, female, prefer not to say, other), race/ethnicity [Black, Hispanic, Asian, or other (selected 'other', multiple responses, or Métis, First Nations, or Inuit as ethics restrictions precluded the identification of students with Indigenous heritage for separate study (Research, n.d.))], and personal spending money (in increments, as available in the COMPASS).

Census division-level measures.

Characteristics of CDs across British Columbia, Alberta, Ontario, and Quebec were used. CD are provincially legislated areas or their equivalents, such as regional districts or counties. Models adjusted for median CD-level after-tax household income, proportion of immigrant (in the

past five years) households, proportion of visible minority (i.e., not white, or Indigenous) households, and the proportion of lone-parent (i.e., single-parent) households in each CD.

Statistical analysis: Three-level multi-level modelling

Three-level multi-level models were used to investigate the relationship between CD-level income inequality and each mental health outcome (depression score, anxiety score) over time (e.g., pre- versus peri-COVID-19; level-1) while controlling for both individual (level-2) and CD-level (level-3) characteristics (Diez Roux, 2004). Multi-level models were necessary because repeated measures were clustered within students, who were clustered within CDs. Models were developed using a step-up method. First, intercept-only models were fit to determine the Intraclass Correlation Coefficient (ICC) and quantify the proportion of variance in depressive and anxiety scores explained at each level in each model. Next, bivariate, multi-level analyses helped to identify the unadjusted relationship between CD-level income inequality and each of the outcomes over time. After this, adjusted models were fit that included both CD-level, school-level, and individual-level factors, as well as a cross-level interaction term between CD-level income inequality and time (e.g., peri-COVID-19), to examine if COVID-19 changed the association between income inequality and adolescent mental health.

Weighting.

There was an increase in non-response in the spring of 2020, due to COVID-19 because school closures limited the ability for administrators to distribute surveys. As a result of school closures, COMPASS was administered online, and the response rates were reduced from 83% to 58% [Personal communication with Angelica Amores, COMPASS on December 6, 2021]. The 2019/20 and 2020/21 survey waves were weighted using sampling weights to account for non-response owing to COVID-19.

Results

The study sample included 29,722 students across 43 Census divisions in British Columbia, Alberta, Ontario, and Quebec. The average age of the sample at baseline was 14.9 years [standard deviation (SD)= 1.5] and ranged between 12 and 19 years of age. The majority of the sample self-reported as white (76.3%), female (54.4%), and had weekly spending money of over $100 (20.9%). The mean Gini coefficient at the CD-level was 0.37 (SD=0.03) and the median after-tax household income was $58,891.70 (SD=$8,843.50). The average proportion of visible minority households, single-parent households, and recent immigrant households were 9.9%, 15.4%, and 1.6%, respectively, across CDs. Details on the distribution of the sample are available in Table 5-1. Null models indicated an ICC for depressive scores of 0.02 (95% CI = 0.01, 0.04) within CDs and 0.27 (95% CI =0.26, 0.28) for students over time within CDs. The ICCs for the anxiety scores were 0.03 (95% CI =0.02, 0.05) within CDs and 0.32 (0.32, 0.34) for students over time within CDs.

In an unadjusted analysis, the results demonstrated that a one SD-unit increase in Gini coefficient was associated with a 0.08 score increase in depressive scores (95% CI =0.04, 0.11). Students who completed the COMPASS survey after the onset of COVID reported 0.20-unit higher depressive scores (95% CI=0.16, 0.24) compared to their responses pre-COVID. However, the interaction between z-transformed Gini coefficient and COVID-19 onset was not statistically significant, indicating that the relationship between income inequality and depressive scores did not statistically significantly change in magnitude by the onset of COVID-19. Findings were similar in the adjusted analyses, with students who completed their COMPASS questionnaire following the onset of COVID-19 reporting higher depressive scores (B=0.14, 95% CI=0.10, 0.18) compared to pre-COVID. However, the relationship between income inequality and depressive scores was not statistically significant; nor was the interaction term

between z-transformed Gini coefficient and COVID-19 onset when adjusting for relevant covariates.

For anxiety scores, the unadjusted model demonstrated a significant relationship between income inequality and anxiety scores (B=0.09, 95% CI=0.05, 0.13), COVID onset and anxiety scores (B=0.19, 95% CI=0.17, 0.21), and the interaction between z-transformed income inequality and COVID-19 onset and anxiety scores (B=0.02, 95% CI=0.001, 0.04). The adjusted analyses indicated that the association between income inequality on anxiety scores was significantly changed following the onset of COVID-19 (B=0.02, 95% CI=0.0004, 0.03). A graphical representation of the interaction between z-transformed Gini coefficient and COVID-19 onset on anxiety scores is available in Figure 5-1. Figure 5-1 depicts the estimated probabilities of anxiety scores as associated with CD-level income inequality over time. Based on this figure, it appears that the gaps in anxiety scores between higher and lower income inequality groups widened after the onset of the pandemic. Further, the largest increases in anxiety scores were amongst those with the highest levels of income inequality at baseline and estimated probabilities of anxiety increased after COVID-19 regardless of income inequality level.

Discussion

The results of this study indicated that the association between income inequality and anxiety was statistically significantly exacerbated by the onset of COVID-19, meaning that adolescents attending schools in higher income inequality areas had significantly larger increases in anxiety symptoms from before to during the pandemic than those attending schools in lower income inequality areas. This study also contributes to the existing literature that reports an association between higher income inequality and increased depression and anxiety in

adolescents (Benny, Patte, et al., 2022; Pabayo et al., 2016). Unsurprisingly, the results also indicated that following the onset of COVID-19, both anxiety and depressive scores increased in the sample, as our sample aged throughout the study period.

While income inequality and rates of adolescent adverse mental health are likely on the rise since COVID-19, the association between income inequality and mental health peri-pandemic had not yet been studied. This work is the first to quantify the joint effects of the COVID-19 pandemic and income inequality on adolescent mental health. While earlier work has examined the association between income inequality and adolescent mental health, most studies were cross-sectional in nature; as such, it is unclear if income inequality preceded mental health problems in these studies and the quality of existing evidence is quite low. This work shows that income inequality at baseline is associated with increases in depressive and anxiety symptoms over time.

While the association between income inequality and depression was not statistically significant in this study, the direction of effect is still what we might expect resulting from the COVID-19 pandemic, with higher income inequality being associated with greater increases in depressive scores. It is possible that these non-significant findings are attributable to the complex mechanisms that underlie mental health. For example, researchers have demonstrated that feelings of anxiety oftentimes present before those of depressive symptoms and these conditions are highly comorbid (Beesdo et al., 2009; Kalin, 2020; Kessler & Wang, 2008) and anxiety is more likely to emerge in pre- and mid-adolescence, whereas depression is more commonly onset during adolescence or in early adulthood (Beesdo et al., 2009). Moreover, it is possible that the lack of statistical significance is owing a lag period, by which income inequality may take several years before the impacts incur. This, in tandem with the previous point, may explain the

null association between income inequality and depression in COVID-19. Future longitudinal research is needed to examine potential delayed and/or sustained impacts of income inequality into the ongoing and recovery phases of the pandemic.

Mental health in adolescents has likely worsened since the onset of the COVID-19 pandemic, perhaps owing to worry regarding the virus, but also to isolation and social segregation resulting from public health measures (e.g., school closures). That said, results from a multi-national study indicated that countries that enacted stringent public health orders sooner actually had lower rates of depression in comparison to those that did not implement such measures with haste (Lee et al., 2021). While some studies have demonstrated that mental health in children did not, in fact, worsen as a result of the pandemic (Dabravolskaj et al., 2021), albeit this study was conducted amongst elementary-school-aged children (ages 9 to 12) who are at lower risk for mental health conditions given that most mental health conditions are onset in adolescence and young adulthood.

The current study used a large, school-based dataset to investigate the research question and validated measures of depression and anxiety (i.e., the CES-D and GAD-7, respectively) and included secondary school students across four Canadian provinces. One survey wave (2019/20) had a reduced response rate owing to the onset of the pandemic and shift to online learning and COMPASS distribution, so study weights were developed and applied to improve the generalizability to the typical COMPASS sample. Moreover, this study is the first to investigate the association between income inequality and adolescent mental health during COVID-19 and lends to a growing body of evidence that suggests that income inequality is harmful for adolescent mental health.

Limitations

  The results of the current study should be interpreted bearing in mind limitations. For example, it is important to note that while the COMPASS system draws upon many schools across BC, Alberta, Ontario, and Quebec, convenience sampling techniques are used; therefore, the findings of this work may have limited generalizability to larger populations. However, it is likely that the results could be applied to schools with similar attributes. Recall bias is also possible but likely minimized in the current study because youth were asked to report on feelings of depression in the past week and anxiety in the past-two weeks. Past-week and past-two-week behaviours are likely easier to recall than longer time periods. Reporting bias could occur in terms of responding to the COMPASS survey, in that social desirability bias may occur when youth self-report on their symptoms of mental health and other factors considered in our modelling.

  Another important limitation of the proposed study is residual confounding. Additional confounders and mediators might exist that explain some of the variability in the association between income inequality and adolescent depression and anxiety. For example, lower earners have increased risk of mood disorders compared to higher earners (Lorant et al., 2003; Sareen et al., 2011); as such, it is important to account for absolute income in studies of income inequality to identify independent effects of income inequality on outcomes (R G Wilkinson, 1997). The COMPASS survey does not have information on students' household income, and so we were unable to control for absolute income at the individual-level. Considering this limitation, the median household income at the CD-level and weekly spending money at the individual-level were included in modeling to account for absolute income.

  Further research is necessary to improve our understanding of the relationship between income inequality and adolescent mental health during COVID-19. For example, quasi-

experimental designs could be employed to test the consequences of COVID-19 on the

relationship between income inequality and adolescent mental health.

Conclusions

      The current study demonstrated that income inequality is more highly associated with

increased anxiety symptoms during COVID-19 than prior to COVID-19. These results are

directly applicable to both school-level and upstream policies for mental health and demonstrate

the importance income inequality. This study also contributes to the literature documenting the

potential harms associated with COVID-19 and income inequality.

References

Abedi, M. (2017). Rise of income inequality in Canada 'almost exclusive' to major cities: study.

    Global News. https://globalnews.ca/news/3599083/income-inequality-canada-cities/

Andresen, E. M., Malmgren, J. A., Carter, W. B., & Patrick, D. L. (1994). Screening for

    depression in well older adults: Evaluation of a short form of the CES-D. *American Journal*

    of Preventive Medicine, *10*(2), 77–84.

Beesdo, K., Knappe, S., & Pine, D. S. (2009). Anxiety and anxiety disorders in children and

    adolescents: developmental issues and implications for DSM-V. *Psychiatric Clinics*, *32*(3),

    483–524.

Benny, C., Patte, K. A., Veugelers, P., Leatherdale, S. T., & Pabayo, R. (2022). Income

    inequality and depression among Canadian secondary students: Are psychosocial well-

    being and social cohesion mediating factors? *SSM-Population Health*, *17*, 100994.

Breau, S. (2014). L'inégalité des revenus au Canada. *Nouvelles Perspectives En Développement*

    Régional: Essais En l'honneur de Donald J. Savoie.

Chadi, N., Spinoso-Di Piano, C., Osmanlliu, E., Gravel, J., & Drouin, O. (2021). Mental Health–

    Related Emergency Department Visits in Adolescents Before and During the COVID-19

    Pandemic: A Multicentric Retrospective Study. *Journal of Adolescent Health*, *69*(5), 847–

    850. https://doi.org/https://doi.org/10.1016/j.jadohealth.2021.07.036

Craig, S. G., Ames, M. E., Bondi, B. C., & Pepler, D. J. (2022). Canadian adolescents' mental

    health and substance use during the COVID-19 pandemic: Associations with COVID-19

    stressors. In *Canadian Journal of Behavioural Science / Revue canadienne des sciences du*

    comportement (p. No Pagination Specified-No Pagination Specified). Educational

    Publishing Foundation. https://doi.org/10.1037/cbs0000305

Dabravolskaj, J., Khan, M., Veugelers, P., & Maximova, K. (2021). Mental Health and Wellbeing of 9–12-year-old Children in Northern Canada Before the COVID-19 Pandemic and After the First Lockdown . In *International Journal of Public Health* (Vol. 66). https://www.ssph-journal.org/articles/10.3389/ijph.2021.1604219

De Maio, F. G. (2007). Income inequality measures. *Journal of Epidemiology & Community Health*, *61*(10), 849–852.

Diez Roux, A. V. (2004). The Study of Group-Level Factors in Epidemiology: Rethinking Variables, Study Designs, and Analytical Approaches. *Epidemiologic Reviews*, *26*(1), 104–111. https://doi.org/10.1093/epirev/mxh006

Haroz, E. E., Ybarra, M. L., & Eaton, W. W. (2014). Psychometric evaluation of a self-report scale to measure adolescent depression: the CESDR-10 in two national adolescent samples in the United States. *Journal of Affective Disorders*, *158*, 154–160.

Kalin, N. H. (2020). The Critical Relationship Between Anxiety and Depression. *American Journal of Psychiatry*, *177*(5), 365–367. https://doi.org/10.1176/appi.ajp.2020.20030305

Kessler, R. C., & Wang, P. S. (2008). The descriptive epidemiology of commonly occurring mental disorders in the United States. *Annual Review of Public Health*, *29*, 115–129. https://doi.org/10.1146/annurev.publhealth.29.020907.090847

Leatherdale, S., Brown, K., Carson, V., Childs, R., Dubin, J., Elliot, S., Faulkner, G., Hammond, D., Manske, S., Sabiston, C., Laxer, R., Bredin, C., & Thompson-Haile, A. (2014). The COMPASS study: a longitudinal hierarchical research platform for evaluating natural experiments related to changes in school-level programs, policies and built environment resources. *BMC Public Health*, *14*, 331.

Lee, Y., Lui, L. M. W., Chen-Li, D., Liao, Y., Mansur, R. B., Brietzke, E., Rosenblat, J. D., Ho,

R., Rodrigues, N. B., Lipsitz, O., Nasri, F., Cao, B., Subramaniapillai, M., Gill, H., Lu, C., & McIntyre, R. S. (2021). Government response moderates the mental health impact of COVID-19: A systematic review and meta-analysis of depression outcomes across countries. *Journal of Affective Disorders*, *290*, 364–377. https://doi.org/https://doi.org/10.1016/j.jad.2021.04.050

Left Business Observer. (1993). *Gini says: measuring income inequality*.

Lorant, V., Deliège, D., Eaton, W., Robert, A., Philippot, P., & Ansseau, M. (2003). Socioeconomic inequalities in depression: a meta-analysis. *American Journal of Epidemiology*, *157*(2), 98–112.

Mossman, S. A., Luft, M. J., Schroeder, H. K., Varney, S. T., Fleck, D. E., Barzman, D. H., Gilman, R., DelBello, M. P., & Strawn, J. R. (2017). The Generalized Anxiety Disorder 7-item scale in adolescents with generalized anxiety disorder: Signal detection and validation. *Annals of Clinical Psychiatry : Official Journal of the American Academy of Clinical Psychiatrists*, *29*(4), 227-234A. https://pubmed.ncbi.nlm.nih.gov/29069107

Pabayo, R., Dunn, E., Gilman, S., Kawachi, I., & Molnar, B. (2016). Income inequality within urban settings and depressive symptoms among adolescents. *J Epidemiol Community Health*, *70*(10), 997–1003.

Research, C. I. for H. (n.d.). *CIHR's guidelines for health research involving Aboriginal people. 2007; CIHR, Ottawa*. http://www.cihr-irsc.gc.ca/e/documents/ethics_aboriginal_guidelines_e.pdf

Robinson, E., Sutin, A. R., Daly, M., & Jones, A. (2022). A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic in 2020. *Journal of Affective Disorders*, *296*, 567–576.

https://doi.org/https://doi.org/10.1016/j.jad.2021.09.098

Romano, I., Ferro, M. A., Patte, K. A., & Leatherdale, S. T. (2022). Measurement invariance of
the GAD-7 and CESD-R-10 among adolescents in Canada. *Journal of Pediatric
Psychology*, *47*(5), 585–594.

Sareen, J., Afifi, T. O., McMillan, K. A., & Asmundson, G. J. G. (2011). Relationship between
household income and mental disorders. *Archives of General Psychiatry*, *68*(4), 419.
https://doi.org/10.1001/archgenpsychiatry.2011.15

Saunders, N. R., Kurdyak, P., Stukel, T. A., Strauss, R., Fu, L., Guan, J., Fiksenbaum, L., Cohen,
E., Guttmann, A., Vigod, S., Chiu, M., Hepburn, C. M., Moran, K., Gardner, W., Cappelli,
M., Sundar, P., & Toulany, A. (2022). Utilization of Physician-Based Mental Health Care
Services Among Children and Adolescents Before and During the COVID-19 Pandemic in
Ontario, Canada. *JAMA Pediatrics*, *176*(4), e216298–e216298.
https://doi.org/10.1001/jamapediatrics.2021.6298

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for
assessing generalized anxiety disorder: the GAD-7. *Archives of Internal Medicine*, *166*(10),
1092–1097.

Statistics Canada. (2020a). *Economic impacts and recovery related to the pandemic*.
https://www150.statcan.gc.ca/n1/en/pub/11-631-x/2020004/s5-eng.htm

Statistics Canada. (2020b). *Table 11-10-0134-01 Gini coefficients of adjusted market, total and
after-tax income*. Data.

StatsCAN Plus. (2022). *Youth mental health in the spotlight again, as pandemic drags on*.
https://www.statcan.gc.ca/o1/en/plus/907-youth-mental-health-spotlight-again-pandemic-
drags

Stephenson, J. (2021). Children and Teens Struggling with Mental Health During COVID-19

   Pandemic. *JAMA Health Forum*, *2*(6), e211701–e211701.

   https://doi.org/10.1001/jamahealthforum.2021.1701

Tiirikainen, K., Haravuori, H., Ranta, K., Kaltiala-Heino, R., & Marttunen, M. (2019).

   Psychometric properties of the 7-item Generalized Anxiety Disorder Scale (GAD-7) in a

   large representative sample of Finnish adolescents. *Psychiatry Research*, *272*, 30–35.

Tjepkema, M., Christidis, T., Bushnik, T., & Pinault, L. (2019). Cohort profile: The Canadian

   Census Health and Environment Cohorts (CanCHECs). *Health Reports*, *30*(12), 18–26.

Wilkinson, R. G. (1997). Socioeconomic determinants of health. Health inequalities: relative or

   absolute material standards? *BMJ*, *314*(7080), 591–595.

   https://doi.org/10.1136/bmj.314.7080.591

Figure 5-1. Line graph demonstrating the graphical representation of the interaction between z-transformed Gini coefficient (at values of -3, -1, 1, and 3) and COVID-19 onset (pre, versus peri-) on the predicted probability of anxiety scores, COMPASS 2018/19-2020/21.
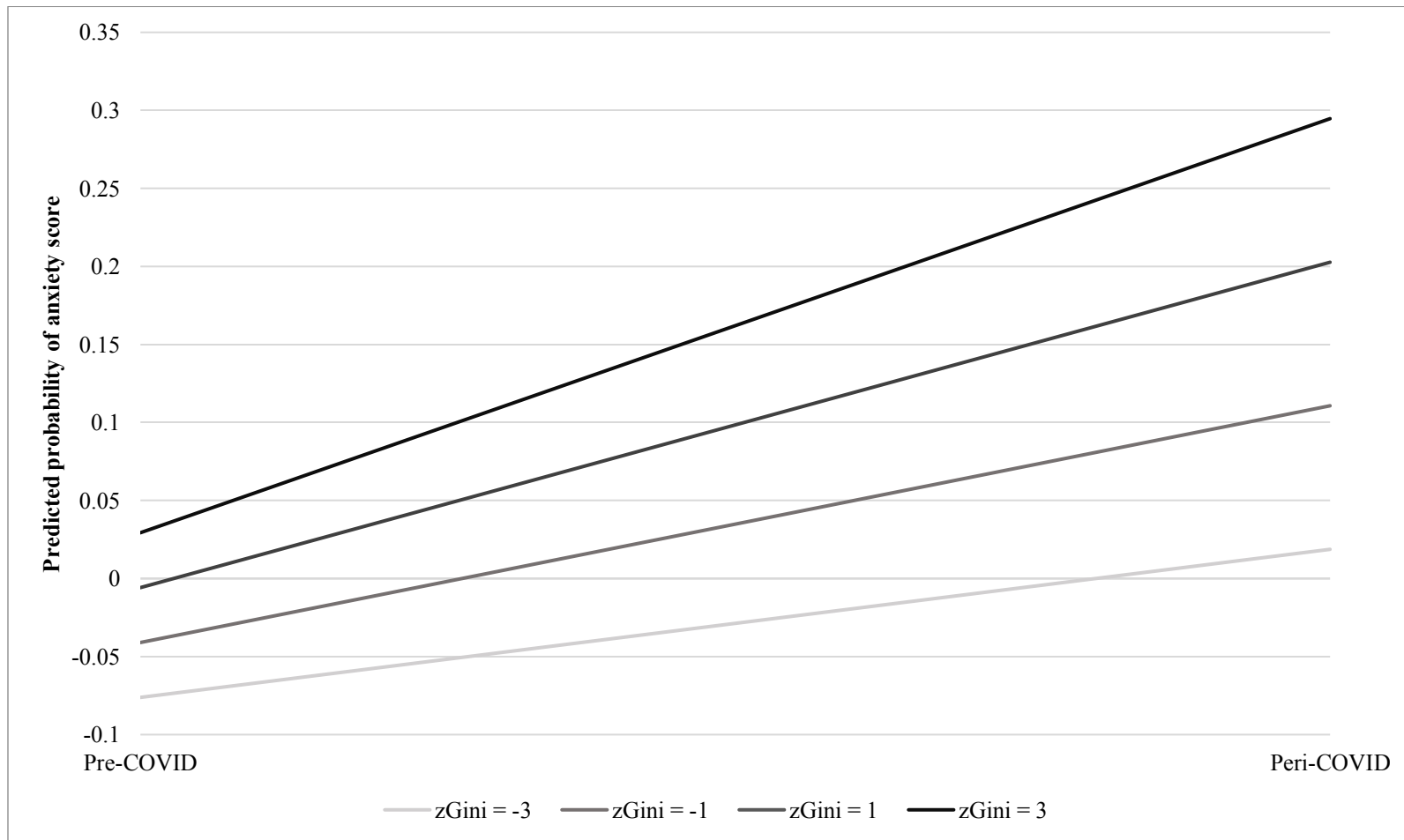
Table 5-1. Table describing the distribution of the COMPASS sample in 2018/19.

		n	*%*
Individual-level characteristics			
Gender	Girl	16,077	54.4
	Boy	13,479	45.6
Race/Ethnicity	White	22,517	76.25
	Black	929	3.15
	Asian	2,426	8.22
	Hispanic	838	2.84
	Other	2,820	9.55
Weekly Spending Money	$0	4,856	20.45
	$1 to $5	1,869	7.87
	$6 to $10	2,132	8.98
	$11 to $20	3,604	15.18

$21 to $40	3,070	12.93
$41 to $100	3,256	13.71
More than $100	4,958	20.88
	Mean	**SD**
Age	14.88	1.52

School-level characteristics	***n***	**%**
Private	8	6.20
Public	121	93.80

CD-level characteristics		
Gini coefficient	0.37	0.03
Visible minority %	0.10	0.12
Lone parent %	0.15	0.02
Recent immigrant %	0.02	0.01
	Median	**SD**
After-tax household income	58891.70	8843.50

Table 5-2. Table describing the unadjusted and adjusted relationship between income inequality and depressive scores in COVID-19, COMPASS 2018-2021.

		Unadjusted model				Adjusted model			
			95 % CI				95 % CI		
		Coef.	Lower bound	Upper bound	p-value	Coef.	Lower bound	Upper bound	p-value
CD-level z-transformed Gini coefficient (zGini)		0.08	0.04	0.11	<0.001	0.02	-0.005	0.04	0.124
COVID	(ref: pre-COVID)	0.20	0.16	0.24	<0.001	0.14	0.10	0.18	<0.001
Interaction term	zGini * COVID	0.01	-0.02	0.03	0.660	0.0002	-0.02	0.03	0.98
% of visible minority households						-0.02	-0.07	0.02	0.331
% of lone-parent households						0.04	0.02	0.07	<0.001
% of recent immigrant households						0.01	-0.04	0.04	0.964
Median household income						0.07	0.05	0.09	<0.001
Gender	Boy (ref: Girl)					-0.50	-0.53	-0.47	<0.001
	Other description					0.71	0.61	0.82	<0.001
	Prefer not to say					0.30	0.21	0.38	<0.001
Race/Ethnicity	Black (ref:					0.04	-0.002	0.08	0.064

	non-white)								
	Asian					0.05	0.02	0.08	0.001
	Hispanic					0.09	0.06	0.13	<0.001
	Other					0.19	0.16	0.23	<0.001
Weekly spending money	$1 to $5 (ref: $0)					-0.04	-0.06	-0.01	<0.001
	$6 to $10					-0.07	-0.10	-0.04	0.003
	$11 to $20					-0.08	-0.12	-0.05	<0.001
	$21 to $40					-0.09	-0.13	-0.06	<0.001
	$41 to $100					-0.10	-0.15	-0.05	<0.001
	More than $100					-0.07	-0.10	-0.03	0.001
Age	In years					0.05	0.05	0.06	<0.001
School type	Private (ref: Public)					-0.10	-0.12	-0.08	<0.001
Intercept		-0.03	-0.07	0.02	0.239	-0.55	-0.67	-0.43	<0.001

Table 5-3. Table describing the unadjusted and adjusted relationship between income inequality and anxiety scores in COVID-19, COMPASS 2018-2021.

		Unadjusted model				Adjusted model			
			95 % CI				95 % CI		
		Coef.	Lower bound	Upper bound	p-value	Coef.	Lower bound	Upper bound	p-value
CD-level z-transformed Gini coefficient (zGini)		0.09	0.05	0.13	<0.001	0.02	-0.01	0.05	0.173
COVID	(ref: pre-COVID)	0.19	0.17	0.21	<0.001	0.13	0.11	0.15	<0.001
Interaction term	zGini * COVID	**0.02**	**0.00**	**0.04**	**0.038**	**0.02**	**0.01**	**0.03**	**0.04**
% of visible minority households						-0.02	-0.08	0.04	0.431
% of lone-parent households						0.07	0.05	0.10	<0.001
% of recent immigrant households						0.003	-0.06	0.05	0.992
Median household income						0.08	0.06	0.11	<0.001
Gender	Boy (ref: Girl)					-0.60	-0.64	-0.55	<0.001
	Other description					0.49	0.37	0.61	<0.001
	Prefer not to say					0.09	-0.02	0.20	0.102

Variable	Category					Estimate	Lower	Upper	p
Race/Ethnicity	Black (ref: non-white)					-0.11	-0.16	-0.06	<0.001
	Asian					-0.09	-0.12	-0.06	<0.001
	Hispanic					0.03	-0.03	0.04	0.844
	Other					0.12	0.09	0.15	<0.001
Weekly spending money	$1 to $5 (ref: $0)					-0.02	-0.05	0.01	0.123
	$6 to $10					-0.05	-0.08	-0.02	0.001
	$11 to $20					-0.07	-0.10	-0.04	<0.001
	$21 to $40					-0.06	-0.09	-0.03	<0.001
	$41 to $100					-0.05	-0.09	-0.01	0.007
	More than $100					-0.01	-0.04	0.03	0.774
Age	In years					0.05	0.04	0.06	<0.001
School type	Private (ref: Public)					-0.08	-0.09	-0.06	<0.001
Intercept		-0.01	-0.07	0.04	0.580	-0.43	-0.54	-0.33	<0.001

Chapter 6, Article 4: Investigating the association between income inequality in youth and deaths of despair in Canada, a population-based cohort study from 2006 to 2019.

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Abstract

Background. Deaths due to suicide, drug overdose, and alcohol-related liver disease, collectively known as 'deaths of despair', have been markedly increasing since the early 2000s and are especially prominent in young Canadians. Income inequality has been linked to this rise in deaths of despair; however, this association has not yet been examined in a Canadian context, nor at the individual-level or in youth. The study objective was to examine the association between income inequality in youth and deaths of despair among youth over time.

Methods. We conducted a population-based longitudinal study of Canadians aged 20 years or younger using data from the Canadian Census Health and Enviroment Cohorts (CanCHEC). Baseline data from the 2006 Canadian Census was linked to the Canadian Vital Statistics Database (CVSD) up to 2019. We employed multi-level survival analysis models to quantify the association between income inequality in youth and time-to deaths of despair.

Results. The study sample included 1.5 million Canadians, representing 7.7 million Canadians between the ages of 0 and 19 at baseline. Results from the weighted, adjusted multi-level survival models demonstrated that income inequality was associated with an increased hazard of deaths of despair [adjusted hazard ratio (AHR): 1.35; 95% CI: 1.04, 1.75], drug overdose (AHR: 2.38; 95% CI: 1.63, 3.48), and all-cause deaths (AHR: 1.10; 95% CI: 1.04, 1.18). Income inequality was not significantly associated with suicide deaths (AHR: 1.23, 95% CI: 0.93, 1.63).

Conclusion. The results show that higher levels of income inequality in youth are associated with an increased hazard of all-cause death, deaths of despair, and drug overdose in young Canadians. This study is the first to reveal the association between income inequality and deaths of despair in youth and does so using a population-based longitudinal cohort involving multi-

level data. The results of this study can inform policies related to income inequality and deaths of despair in Canada.

Introduction

Deaths attributable to suicide, drug overdose, and alcohol-related liver disease are collectively referred to as "deaths of despair", a term coined by researchers Anne Case and Angus Deaton. In their work, they identify marked increases in all-cause mortality among white, working age Americans from 1999 to 2013 and highlight the reduction in life expectancy from birth in the United States owing to deaths of despair (Case & Deaton, 2015). While these trends are widely recognized in the United States, staggering rates of suicide, drug overdose, and alcohol-related liver disease also exist in the Canadian context. Suicide has been a leading cause of death in Canada since the 1990s and deaths due to drugs and alcohol are on the rise (Global Burden of Disease, 2013). From 2000 to 2019, mortality rates have increase from 2.98 to 6.92 per 100,000 for drug overdose and 3.54 to 4.57 per 100,000 for alcohol-related liver disease (Global Burden of Disease, 2013). The same patterns identified by Case and Deaton in their seminal work are recently apparent among Canadians as well, with all-cause mortality rates increasing from 731.84 per 100,000 in 2016 to 789.14 per 100,000 in 2019 (Global Burden of Disease, 2013). Youth are also at risk for premature death, as suicide is the second leading cause of death among Canadian youth and drug poisoning rates have skyrocketed, likely owing to contamination of the drug supply and leading to increased deaths associated with drug overdose (Global Burden of Disease, 2013; Wiens et al., 2020). Youth may be particularly vulnerable to drug overdose associated with contamination, given inexperience with drugs and lack of reasonable access to drug checking services (World Health Organization, 2015). Despite the heightened risk of deaths of despair in youth, no existing studies have investigated the risk factors for such deaths in this population.

Income inequality, defined as the differences in income within a given group or area, is a major risk factor for adverse mental health (Vikra Patel et al., 2018) and death (J. W. Lynch et al.,

2000). For example, a wide gap in incomes suggests that a proportion of the population has a disproportionately higher or lower income than others. In contrast, a narrow gap in incomes suggests that there is little variability of incomes within a given group or area. The income inequality hypothesis supposes that a person's health is not just influenced by their level of income, but rather the distribution of incomes in the area in which they live (De Maio, 2014).

Adverse mental health is strongly associated both with substance use (Volkow, 2004) and suicidality and suicide (Cheung & Dewa, 2006). Specifically, depression and anxiety may be associated with increased vulnerability to negative emotions and difficulty coping. Substance use, in some situations, can be used as a coping mechanism for dealing with these emotions (Wills et al., 2001). Excess substance use is a causal factor for alcohol-related liver disease and drug dependence and can lead to subsequent death. Use and dependence may be exacerbated during adolescence, because youth may have lower tolerance to substances when compared to adults and/or may use substances to cope with mental health problems in the absence of appropriate and accessible care (Wills et al., 2001). Further, those who begin drug use in adolescence are at particularly high risk of dependence later in life. Substance use in youth may disrupt healthy development, and some evidence shows that experiencing income inequality can also be harmful. However, very few studies investigate the effects of income inequality on youth and no studies have detailed the association between income inequality and deaths of despair specifically among individuals in this age group.

A review of the existing literature highlights evidence detailing the association between income inequality and the risk for death of despair in the general population (e.g., suicide, drug overdose, and alcohol-related liver disease). Most of this research examines the potential impact of income inequality on suicide deaths (Fernquist, 2003; Miller et al., 2005), although the literature

is mixed (Auger et al., 2009). Higher income inequality as associated with increased risk of drug overdose (Galea et al., 2003; Nandi et al., 2006). Finally, mixed evidence suggests that higher income inequality is associated with increased alcohol-related deaths (Dietze et al., 2009), with the findings from one study demonstrating a protective effect between high income inequality and alcohol-related deaths in Quebec, Canada (Auger et al., 2009). Quasi-experimental evidence observed in difference-in-difference models suggest that higher minimum wage and earned income tax credits (policies that can reduce income inequality) may be protective against non-drug suicide-related mortality rates (Dow et al., 2020). It is important to note that existing studies were primarily ecological in nature, and none detailed the relationship between income inequality and deaths of despair in Canada. Moreover, no existing studies have investigated the potential for gender differences in the association between income inequality and deaths of despair, which is surprising considering that research indicates that girls and boys respond differently to their social environments and experience mental health problems differently (Pabayo et al., 2016).

Likewise, the association income inequality and deaths of despair in any capacity has not been investigated in youth. This is surprising given that income inequality is known to have detrimental effects on youth mental health (Pabayo et al., 2016; Vilhjalmsdottir et al., 2019), and youth are at increased risk of deaths due to suicide and drug overdose (Global Burden of Disease, 2013; Wiens et al., 2020). Evidence on the mechanisms linking income inequality in youth on risk of deaths of despair is limited; however, three main mechanisms in the general population are recognized in the existing literature (I Kawachi & Kennedy, 1999). First, in line with the divestment in human capital postulation, divestment in harm reduction services may result in the closure of supervised consumption sites and an influx in drug overdoses within areas with high income inequality (Public Health Ontario, 2020). Similarly, lack of access or closures of youth-appropriate mental health

services within areas with high income inequality may be associated with increased risk of self-medicating coping behaviours and even suicidality (Wills et al., 2001). Another proposed mechanism is that income inequality leads to the erosion of social capital, resulting in reducing connectedness, mutual aid, and trust between residents within communities and neighbourhoods. This can lead to isolation and segregation, which are risk factors for substance use (Zoorob & Salemi, 2017) and suicide (Trout, 1980), particularly among youth. Finally, the existing literature demonstrates that income inequality and suicidality are associated through feelings of inferiority and superiority, as generated by social comparisons (I Kawachi & Kennedy, 1999). It stands to reason that youth living within high income inequality areas may experience these feelings, alongside those of shame, inferiority, and superiority, could potentially increase the risk of deaths of despair in youth.

Studying income inequality and deaths of despair in youth is of the utmost importance, given that youth also experience the detrimental effects of income inequality and suicide and drug overdose are leading causes of death among young people in Canada (Global Burden of Disease, 2013; Wiens et al., 2020). No earlier studies have investigated this association despite the clear gap in the field. As such, the current study aims to quantify the association between income inequality and deaths of despair in a population-based longitudinal sample of Canadian youth.

Methods

Sample: CanCHEC 2006-2019

A longitudinal cohort study was conducted using data form the 2006 Canadian Census Health and Enviroment Cohorts (CanCHEC). The CanCHEC includes consenting participants from the 2006 Census who were then probabilistically linked to the Canadian Vital Statistics Database (CVSD) for deaths from 2006 to 2019. The CanCHEC sampling methods has been

described elsewhere (Tjepkema et al., 2019). Long-form 2006 Census respondents were eligible for the CanCHEC if they were usual residents of Canada on Census Day and were not living in institutions (e.g., nursing homes, group homes, penitentiaries). Depending on the year, the linkage rate falls between 99.6 and 99.9% for the CVSD (Tjepkema et al., 2019). The CVSD collects demographic and cause of death information annually from all provincial and territorial vital statistics registries in Canada, capturing virtually all deaths among Canadians.

The sample included all Canadians under the age of 20 in the 2006 CanCHEC. The 2006 CanCHEC had no minimum age restrictions and included an unweighted sample size of 5.87 million respondents (Statistics Canada, n.d.), with 1,480,235 respondents under the age of 20 who were considered in this study. The fourteen-year follow-up means that the oldest youth at baseline could have reached age 33 by the end of the study period.

Measures

Exposure measure: Income inequality.

To measure relative income inequality, the Gini coefficient was quantified at the Census division (CD)-level (Left Business Observer, 1993). CDs are geographic areas between municipal- and province-level areas, are provincially legislated, and are often synonymous with the terms "regional district" or "county" (Statistics Canada, 2012). The calculation of the Gini coefficient is conceptualized by the Lorenz curve and is measured by dividing the area between the Lorenz curve of an income distribution and the distribution line of incomes within an area by the area under the distribution line, with the Lorenz curve representing the proportion of the total income of the population that is cumulatively earned by the lowest earners in the population. Gini coefficient was standardized using a z-transformation to lend to interpretability. As such, estimates can be interpreted as resulting from a one-unit standard deviation (SD) increase in Gini Coefficient.

Outcome: Deaths of despair and survival time.

The primary outcome was the mortality caused by deaths of despair in the CVSD. International Classification of Diseases (ICD) using versions in effect at time of death were used to identify the following causes of death:

• Drug overdose: ICD-10 codes X40-44, X60-64, X85, Y10-14, Y352; opioid analgesics: T-Code 40.2; and illicit opioids: T-Code 40.1, 40.4

• Non-drug suicides: ICD-10 codes X65-X84, Y87.0, U03

• Alcohol-related liver disease: ICD-10 code: K70

We also examined the association between income inequality and all-cause mortality. Due to a limited number of events and concerns re: confidentiality, alcohol-related liver disease was not tested as an independent outcome.

Covariates

Individual-level measures.

Individual-level measures included age (continuous), gender (male, female), after-tax household income (measured in quintiles), immigration status (immigrant, non-immigrant), and visible minority status (visible minority person, non-visible minority person). Visible minority status included those who identify as non-Indigenous and non-white.

CD-level measures.

The area-level units of analysis were the 288 CDs in Canada. CDs were selected, as officials and organizations within CDs have the authority to make policy decisions for that CD and so some programs for reducing income inequality or for targeting mental health problems may be made at this level. CD-level characteristics from the CanCHEC included: mean household income,

proportion of lone parent households, and proportion of households with at least one person having graduated from high school.

Statistical analysis: Multi-level survival analysis

We calculated frequencies, means, and proportions of key variables as well as correlation matrices at the individual and CD-levels as appropriate to provide some insight into our sample. Next, because youth were nested within residential areas, two-level survival models were conducted to determine if there was an association between income inequality in youth and time to deaths of despair (Austin, 2017). In the two-level survival model, a CD-specific random effect was included as a frailty term in the Cox's proportional hazards model and frailty is usually assumed to have a gamma distribution. As per Austin and colleagues, the within-CD variation is equal where θ is the variance of the gamma distribution (Austin, 2017). Our survival analysis models were developed using a step-up modelling approach. First, the unadjusted association between income inequality and deaths of despair was estimated. Next, CD- and individual-level factors were added. These steps were followed for the composite measure of all-cause mortality, deaths of despair, and each type of death of despair, as the outcome.

In further models, we tested the addition of an interaction term between z-transformed Gini coefficient and gender and incorporated random effects for gender; however, the interaction term was not statistically significant and so these results were not presented. The **"mestreg"** command in STATA MP was used to fit two-level survival models.

Survival time was measured from study baseline to the time of death or end of the study period (December 31, 2019). If a death did not occur during the follow-up period, or a death attributable to another outcome occurred, the outcome was considered censored, and the survival time will be the time to the end of the study period.

The data were weighted with Statistics Canada sampling weights to allow us to generalize findings to all Canadian youth in the Census.

Research ethics board approval for this study was obtained through the University of Alberta (Project ID: RES0052784). The analyses for the current study were conducted in and with the support of the Canadian Research Data Centre Network (CRDCN). In accordance with CRDCN policies, only weighted analyses (including descriptive statistics) are reported. Frequencies and proportions of the weighted sample characteristics are reported based on rounding to base five, as per CRDCN guidelines.

Sensitivity analyses

Additional models were developed in a subgroup of the original sample under the assumption that those who only reached a maximum of 1) thirteen years of age and 2) eighteen years of age were excluded from the analytical sample. In the first set of sensitivity analyses, those below the age of one year at baseline were removed from the sample. The same analytic strategy outlined above was conducted in the revised cohort. Next, a second set of sensitivity analyses involved the removal of all those under age five at baseline from the sample. Again, the same analytic strategy detailed above was carried out in this revised cohort. (Please note that the sensitivity analyses outlined in this thesis were not published in the article cited in the preface of this thesis: Benny C, Smith BT, Hyshka E, Senthilselvan A, Veugelers PJ, Pabayo R. Investigating the association between income inequality in youth and deaths of despair in Canada: a population-based cohort study from 2006 to 2019. J Epidemiol Community Health. 2022 Nov 2.).

Results

The unweighted study sample included 1.7 million subjects, representing 7.7 million Canadians between the ages of 0 and 19 at study baseline. In the weighted sample, 38,005 deaths occurred over the study period, with 1,140 of those owing to deaths of despair (930 and 205 for suicide and drug overdose, respectively).

The distribution of all sample characteristics at baseline are shown in Table 6-1. The weighted sample was 51.3% male, the majority of which were non-immigrant (92.0%) and reported being white persons (75.0%). On average, participants at baseline were 10.1 years of age (SE=0.03) and lived in Census divisions with an average after-tax household income of $54,434.19 (SE=$1,575.78). We have also reported on the variance of the random intercept in null models for each outcome to illustrate the baseline hazard function while including Census division-level data in our analyses. The null models demonstrated that including CD-level information into our models explained some additional variation in each of the outcomes [i.e., variances coefficients of the random intercept for the deaths of despair, suicide, drug overdose, and all-cause death models were 4.60 (95% CI: 3.33, 6.35), 5.79 (95%: 4.15, 8.09), 4.25 (95% CI: 2.70, 6.68), and 0.35 (95% CI: 0.28, 0.44), respectively]. As such, the within-CD-level variation for the two-level model for all-cause death, deaths of despair, suicide, and drug overdose were 0.15, 0.70, 0.74, and 0.68, respectively. Correlation matrices of all included covariates are available in Appendix B, Supplemental Tables B-5 and B-6. None of the variables were strongly correlated, indicating that multicollinearity was not a concern.

The unadjusted and adjusted results from the multi-level models are shown in Table 6-2, Table 6-3, Table 6-4, and Table 6-5 for deaths of despair, suicide, drug overdose, and all-cause mortality, respectively. As shown in Table 6-2, Table 6-3, Table 6-4, and Table 6-5, a standard

deviation (SD) unit increase in Gini Coefficient was associated with an increase in the hazard ratio for deaths of despair (HR: 1.78, 95% CI:1.37, 2.31), suicide (HR: 1.68, 95% CI: 1.27, 2.22), drug overdose deaths (HR: 2.66 95% CI: 1.88, 3.77), and for all-cause mortality (HR: 1.16; 95% CI: 1.06, 1.26), respectively.

As shown Table 6-2, Table 6-4, and Table 6-5, adjusted multi-level survival models demonstrated that a SD-unit increase in Gini coefficient was associated with an increased hazard of deaths of despair (aHR: 1.35; 95% CI: 1.04, 1.75), drug overdose (aHR: 2.38; 95% CI: 1.63, 3.48), and all-cause deaths (aHR: 1.10; 95% CI: 1.04, 1.18). As shown in Table 5-3, the association between income inequality and suicide risk was not statistically significant in the adjusted model (aHR: 1.23; 95% CI: 0.93, 1.63). Plots of smoothed, adjusted hazard functions are available in Figures 6-1, 6-2, and 6-3 for deaths of despair, suicide, and drug overdose, respectively. As seen in these figures, hazard for deaths of despair events all increased over the follow-up period.

Sensitivity analyses

The results of the sensitivity analyses outlined in the methods section of this paper were consistent with those outlined in the thesis apart from the time-to-suicide model excluding those under five years of age at baseline, where models did not have sufficient power for reliable results.

Discussion

The findings of this study highlight an association between income inequality in youth and risk for deaths of despair over time. Specifically, we observed that higher levels of income inequality in youth are associated with increased hazard of all-cause death, deaths of despair, and drug overdose among Canadians, while adjusting for confounders.

This novel study uses a Statistics Canada linked data product with sampling weights to improve the external validity of the results. By using Statistics Canada vital statistics data, we were able to capture virtually all deaths among youth reported in Canada. While this study investigating the association between income inequality and deaths of despair in youth is the first of its kind, results are in line with existing evidence that suggests that income inequality is associated with adverse mental health outcomes and mortality. For example, a study by Auger and colleagues found that income inequality within urban settings was associated with all-cause mortality amongst working age people born in Canada for men (Auger et al., 2012). In line with our findings regarding income inequality and suicide, one ecological study has demonstrated that income inequality within areas of health service delivery in Quebec was not significantly associated with suicide, specifically in areas with moderate income inequality (Auger et al., 2009). While several existing studies have linked income inequality to suicide deaths in other contexts (Fernquist, 2003; Miller et al., 2005), the findings from this population-based study do not provide statistically significant evidence of an association when adjusting for relevant covariates. It is possible that lack of statistical significance is driven by power, considering that relatively few suicide deaths occurred over the follow-up period. Despite this, the current study contributes to some gaps in the literature, considering that existing studies are primarily ecological, and none have described the association between income inequality and collective deaths of despair in any context. Also, this study fills a key gap in the literature given that it is the first to investigate income inequality and deaths of despair specifically in youth.

Research has demonstrated that living or attending schools in areas with higher income inequality has detrimental effects on adolescent health. For example, research has indicated higher income inequality was associated with an increased risk of mental health problems and

emotional distress (Vilhjalmsdottir et al., 2019) and depression (Benny, Patte, et al., 2022; Pabayo et al., 2016) in youth; albeit, only cross-sectionally. Adverse mental health may manifest in feelings of mistrust, isolation, hopelessness, and behavioural problems in adolescents, which can make it more difficult seek treatment or help, which can worsen mental health and may lead to self-regulated coping (e.g., self-medication with substance use). While such issues are of great public health importance, it is also important to consider further subsequent, more severe implications including mortality and deaths of despair. While premature death, such as those attributable to deaths of despair, may lead to reductions in life expectancy and soaring increases in disability adjusted life-years; there can also be devastating effects on communities, families, and social networks. It is important to understand the social risk factors of deaths of despair in youth to inform targeted prevention and harm reduction programs.

The authors note that the term "deaths of despair" can be seen as a misleading label. The term itself implies despair as the direct etiology of deaths owing to suicide, alcohol-related liver disease, and drug overdose, when the direct events preceding such deaths are more likely multi-faceted. For example, deaths due to drug overdose are more likely attributable to contaminants in drug supplies (e.g., synthetic opioids such as fentanyl) than despair (Dowell et al., 2017). As such, we caution against the assumption that the deaths examined in this paper are solely attributable to despair.

Limitations.

One limitation of the study design is that income inequality and other covariates were only measured at baseline in 2006. This is because the 2011 long-form Canadian Census was not mandatory, and, therefore, selection biases may be present in calculating income inequality at that point in time. It is possible that young people who once lived in more unequal CDs may

have migrated to more equal CDs. Likewise, it is possible that young people who lived in more equal CDs may have migrated to more unequal CDs. This movement could produce biased estimates of the hazard of deaths of despair. Moreover, we could not determine the length of time each respondent was exposed to income inequality prior to the recorded Census date. Exposure to income inequality may be dose dependent. That said, researchers have demonstrated that the effects of income inequality are lagged (Zheng, 2012). For instance, the results from a large US study detailing the association between income inequality and all-cause mortality from 1986 to 2006 highlight that the effects of income inequality peak at seven years post-exposure (Zheng, 2012). Given that, the maximum thirteen-year follow-up period between baseline responses to the Census and the follow-up period may be a strength of this study.

Some selection biases may exist relating to the long-form Census. Specifically relating to our study, people who use drugs, are institutionalized, and/or experience mental health problems are less likely to respond to surveys (T. P. Johnson, 2014). As such, those at highest risk for deaths of despair may be underrepresented in the current study and our results may be biased; however, sampling weights applied to the data likely alleviate this concern. There are, however, other limitations of the CanCHEC and Census (Tjepkema et al., 2019). For example, respondents who report their address to be at a business or post office may have incorrect geographical information as the postal code for these spaces may be quite different from their residential address. The CVSD, however, is a comprehensive source of data that collects information on virtually all deaths in Canada as reported by each province, so it is unlikely that selection biases exist owing to this dataset.

Finally, residual confounding may also be a limitation of the study. Additional confounders that are not available in the Census or CVSD may exist that explain some of the variability in the

modelling of this study, such as adverse childhood experiences. Further, this study did not investigate the mechanisms by which income inequality contributes to deaths of despair among youth. Future studies should identify potential mediators such as access to mental health or harm reduction services, social support, psychosocial well-being, and social cohesion.

Conclusion

This is the first study not only to examine the association between income inequality and deaths of despair, but to examine this association in youth. Overall, the results of this work can inform policies related to the public health burden of income inequality in Canada. These results have implications for youth mental health and well-being, given that this research can inform discussions on targeted interventions (e.g., counselling, harm reduction programs) for reducing youth mortality via deaths of despair. Future research should evaluate the association between income inequality reducing programs (e.g., increases in minimum wage, cash transfer programs) and deaths of despair amongst youth using quasi-experimental evidence to provide stronger evidence in support of the hypothesis. Also, researchers should consider examining the mechanisms by which income inequality contributes to the risk of deaths of despair amongst youth to provide better support for targeted intervention and to lend to discussion on policy regarding reducing income inequality, given that the findings demonstrate that income inequality may contribute to the risk of deaths of despair among Canadian youth.

References

Auger, N., Hamel, D., Martinez, J., & Ross, N. A. (2012). Mitigating effect of immigration on the relation between income inequality and mortality: a prospective study of 2 million Canadians. *J Epidemiol Community Health*, *66*(6), e5–e5.

Auger, N., Zang, G., & Daniel, M. (2009). Community-level income inequality and mortality in Québec, Canada. *Public Health*, *123*(6), 438–443.

Austin, P. C. (2017). A Tutorial on Multi-level Survival Analysis: Methods, Models and Applications. *International Statistical Review = Revue Internationale de Statistique*, *85*(2), 185–203. https://doi.org/10.1111/insr.12214

Benny, C., Patte, K. A., Veugelers, P., Leatherdale, S. T., & Pabayo, R. (2022). Income inequality and depression among Canadian secondary students: Are psychosocial well-being and social cohesion mediating factors? *SSM-Population Health*, *17*, 100994.

Case, A., & Deaton, A. (2015). Rising morbidity and mortality in midlife among white non-Hispanic Americans in the 21st century. *Proceedings of the National Academy of Sciences*, *112*(49), 15078–15083.

Cheung, A. H., & Dewa, C. S. (2006). Canadian Community Health Survey: Major depressive disorder and suicidality in adolescents. *Healthcare Policy = Politiques de Sante*, *2*(2), 76–89.

De Maio, F. G. (2014). Income Inequality Hypothesis. In *The Wiley Blackwell Encyclopedia of Health, Illness, Behavior, and Society* (pp. 1223–1228). https://doi.org/doi:10.1002/9781118410868.wbehibs312

Dietze, P. M., Jolley, D. J., Chikritzhs, T. N., Clemens, S., Catalano, P., & Stockwell, T. (2009). Income inequality and alcohol attributable harm in Australia. *BMC Public Health*, *9*(1), 1–

9.

Dow, W. H., Godøy, A., Lowenstein, C., & Reich, M. (2020). Can Labor Market Policies

Reduce Deaths of Despair? *Journal of Health Economics*, *74*, 102372.

https://doi.org/https://doi.org/10.1016/j.jhealeco.2020.102372

Dowell, D., Noonan, R. K., & Houry, D. (2017). Underlying factors in drug overdose deaths.

Jama, *318*(23), 2295–2296.

Fernquist, R. M. (2003). Perceived income inequality and suicide rates in Central/Eastern

European countries and Western countries, 1990-1993. In *Death Studies* (Vol. 27, Issue 1,

pp. 63–80). Taylor & Francis. https://doi.org/10.1080/07481180302870

Galea, S., Ahern, J., Vlahov, D., Coffin, P. O., Fuller, C., Leon, A. C., & Tardiff, K. (2003).

Income distribution and risk of fatal drug overdose in New York City neighborhoods. *Drug

and Alcohol Dependence*, *70*(2), 139–148. https://doi.org/10.1016/s0376-8716(02)00342-3

Global Burden of Disease. (2013). GBD Compare. *Seattle: University of Washington*.

Johnson, T. P. (2014). Sources of error in substance use prevalence surveys. *International

Scholarly Research Notices*, *2014*, 1–21. https://doi.org/10.1155/2014/923290

Kawachi, I., & Kennedy, B. (1999). Income inequality and health: pathways and mechanisms.

Health Services Research, *34*(1 pt 2), 215–227.

Left Business Observer. (1993). *Gini says: measuring income inequality*.

Lynch, J. W., Smith, G. D., Kaplan, G. A., & House, J. S. (2000). Income inequality and

mortality: importance to health of individual income, psychosocial environment, or material

conditions. *BMJ (Clinical Research Ed.)*, *320*(7243), 1200–1204.

https://doi.org/10.1136/bmj.320.7243.1200

Miller, J. R., Piper, T. M., Ahern, J., Tracy, M., Tardiff, K. J., Vlahov, D., & Galea, S. (2005).

Income inequality and risk of suicide in New York City neighborhoods: a multilevel case-control study. *Suicide and Life-Threatening Behavior*, *35*(4), 448–459.

Nandi, A., Galea, S., Ahern, J., Bucciarelli, A., Vlahov, D., & Tardiff, K. (2006). What explains the association between neighborhood-level income inequality and the risk of fatal overdose in New York City? *Social Science & Medicine (1982)*, *63*(3), 662–674. https://doi.org/10.1016/j.socscimed.2006.02.001

Pabayo, R., Dunn, E., Gilman, S., Kawachi, I., & Molnar, B. (2016). Income inequality within urban settings and depressive symptoms among adolescents. *J Epidemiol Community Health*, *70*(10), 997–1003.

Patel, V., Burns, J. K., Dhingra, M., Tarver, L., Kohrt, B. A., & Lund, C. (2018). Income inequality and depression: A systematic review and meta-analysis of the associations and a scoping review of mechanisms. *World Psychiatry*, *17*, 76–89.

Public Health Ontario. (2020). *Rapid review: Substance use-related harms and risk factors during periods of disruption*. https://www.publichealthontario.ca/-/media/documents/ncov/main/2020/08/substance-use-related-harms-disruption.pdf?la=en

Statistics Canada. (n.d.). *Table 1 Description of Canadian Census Health and Enviroment Cohorts (CanCHECs)*. 82-003-X. Retrieved August 24, 2021, from https://www150.statcan.gc.ca/n1/pub/82-003-x/2019012/article/00003/tbl/tbl01-eng.htm

Statistics Canada. (2012). *Census division: Detailed definition*. Illustrated Glossary: 92-195-X. https://www150.statcan.gc.ca/n1/pub/92-195-x/2011001/geo/cd-dr/def-eng.htm

Tjepkema, M., Christidis, T., Bushnik, T., & Pinault, L. (2019). Cohort profile: The Canadian Census Health and Environment Cohorts (CanCHECs). *Health Reports*, *30*(12), 18–26.

Trout, D. L. (1980). The role of social isolation in suicide. *Suicide and Life-Threatening*

Behavior, *10*(1), 10–23.

Vilhjalmsdottir, A., De Clercq, B., Gardarsdottir, R. B., Bernburg, J. G., & Sigfusdottir, I. D.

(2019). Decreasing income inequality and adolescent emotional distress: a population-based

case study of Icelandic adolescents 2006–2016. *International Journal of Public Health*,

64(2), 253–263.

Volkow, N. D. (2004). The reality of comorbidity: Depression and drug abuse. In *Biological

Psychiatry* (Vol. 56, Issue 10, pp. 714–717). Elsevier Science.

https://doi.org/10.1016/j.biopsych.2004.07.007

Wiens, K., Bhattarai, A., Pedram, P., Dores, A., Williams, J., Bulloch, A., & Patten, S. (2020). A

growing need for youth mental health services in Canada: examining trends in youth mental

health from 2011 to 2018. *Epidemiology and Psychiatric Sciences*, *29*, e115–e115.

https://doi.org/10.1017/S2045796020000281

Wills, T. A., Sandy, J. M., Yaeger, A. M., Cleary, S. D., & Shinar, O. (2001). Coping

dimensions, life stress, and adolescent substance use: a latent growth analysis. *J Abnorm

Psychol*, *110*(2), 309–323.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation

&list_uids=11358025

Zheng, H. (2012). Do people die from income inequality of a decade ago? *Social Science &

Medicine (1982)*, *75*(1), 36–45. https://doi.org/10.1016/j.socscimed.2012.02.042

Zoorob, M. J., & Salemi, J. L. (2017). Bowling alone, dying together: The role of social capital

in mitigating the drug overdose epidemic in the United States. *Drug and Alcohol

Dependence*, *173*, 1–9.

Figure 6-1. Smoothed, adjusted hazard function plot for deaths of despair, CanCHEC (2006-2019).

Figure showing "Smoothed hazard estimate for deaths of despair" with y-axis labeled "Hazard rate" (ranging from $1.400 * 10^{-7}$ to $2.400 * 10^{-7}$) and x-axis labeled "Analysis time" (0 to 1000).
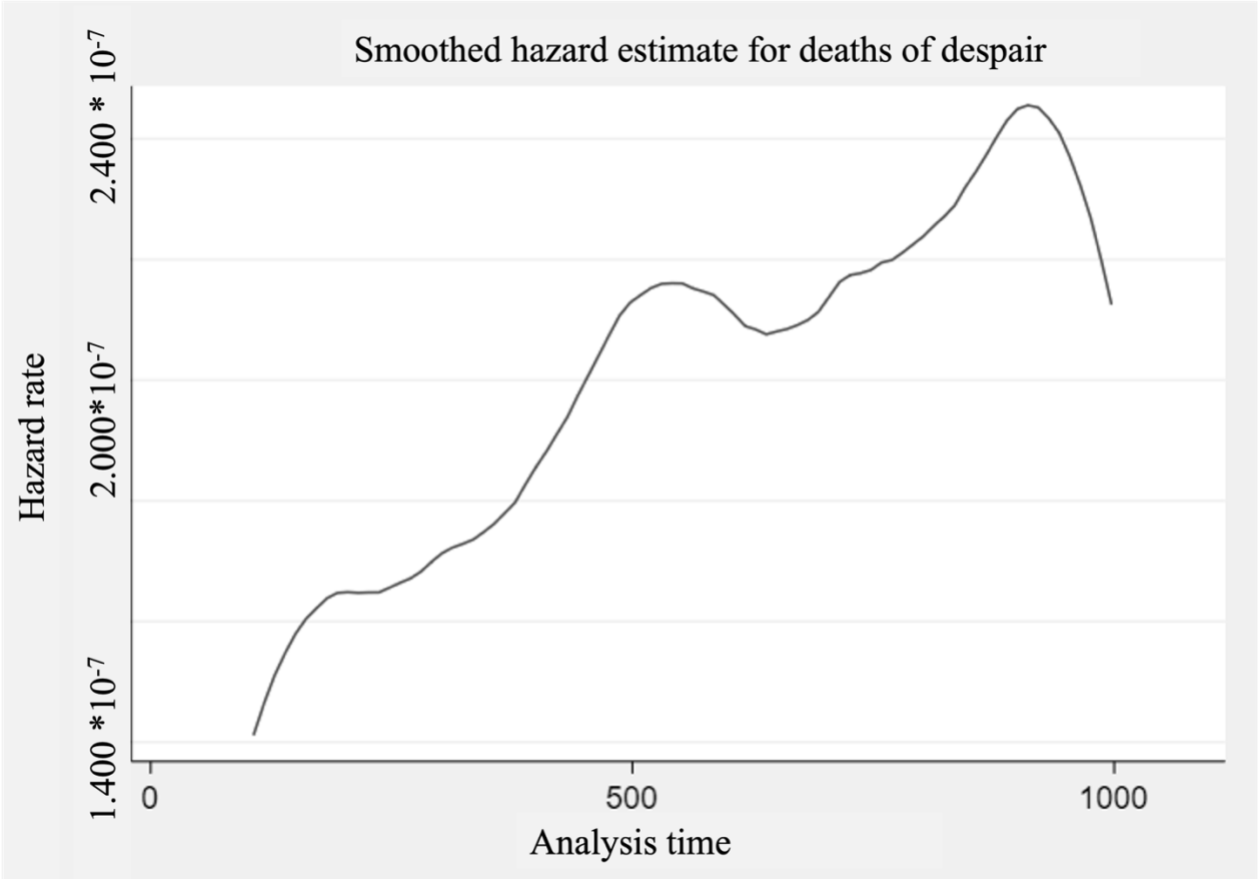
Figure 6-2. Smoothed, adjusted hazard function plot for suicide, CanCHEC (2006-2019).
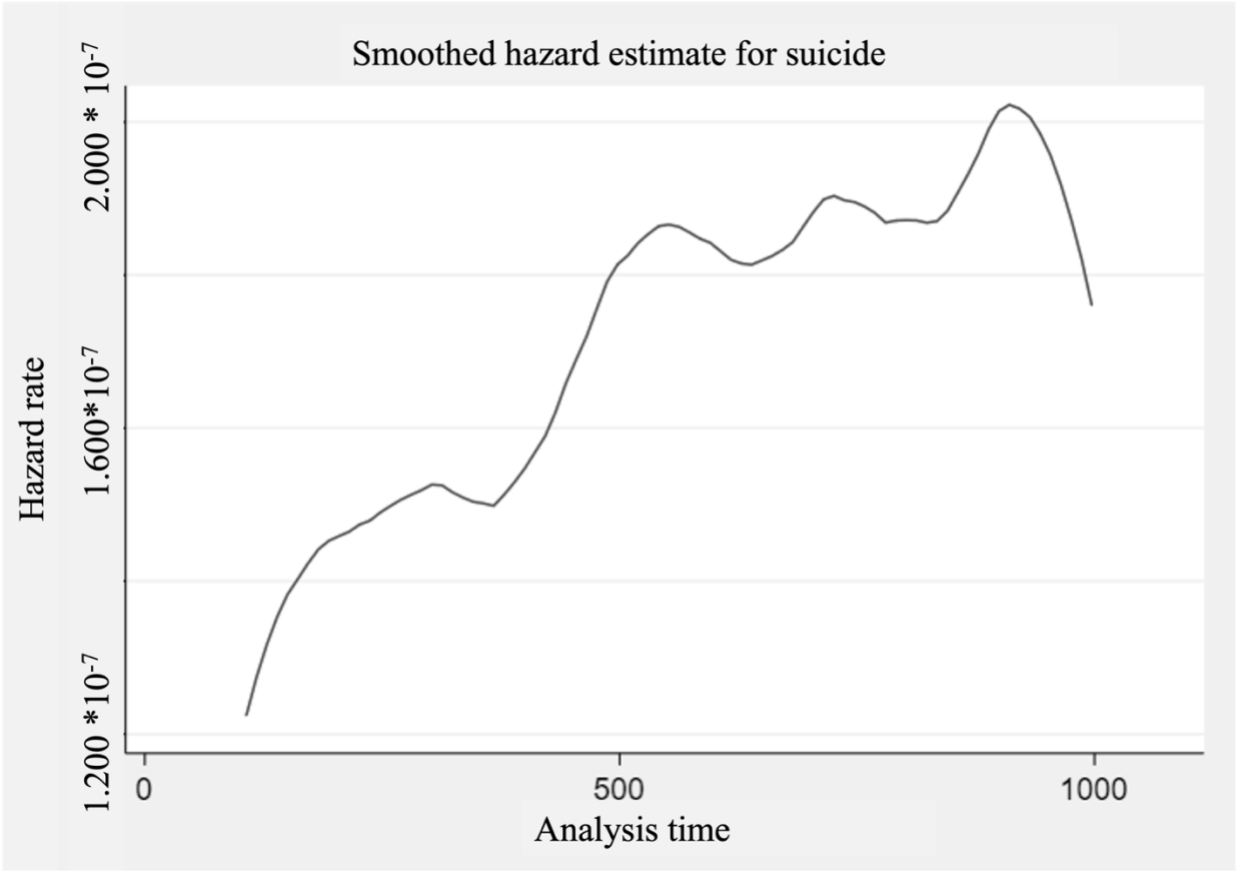
Figure 6-3. Smoothed, adjusted hazard function plot for drug overdose, CanCHEC (2006-2019).

Smoothed hazard estimate for drug overdose

(Y-axis: Hazard rate; labeled 1.500 *10⁻⁸, 2.750*10⁻⁸, 4.000 * 10⁻⁸)

(X-axis: Analysis time; 0, 200, 400, 600, 800, 1000)
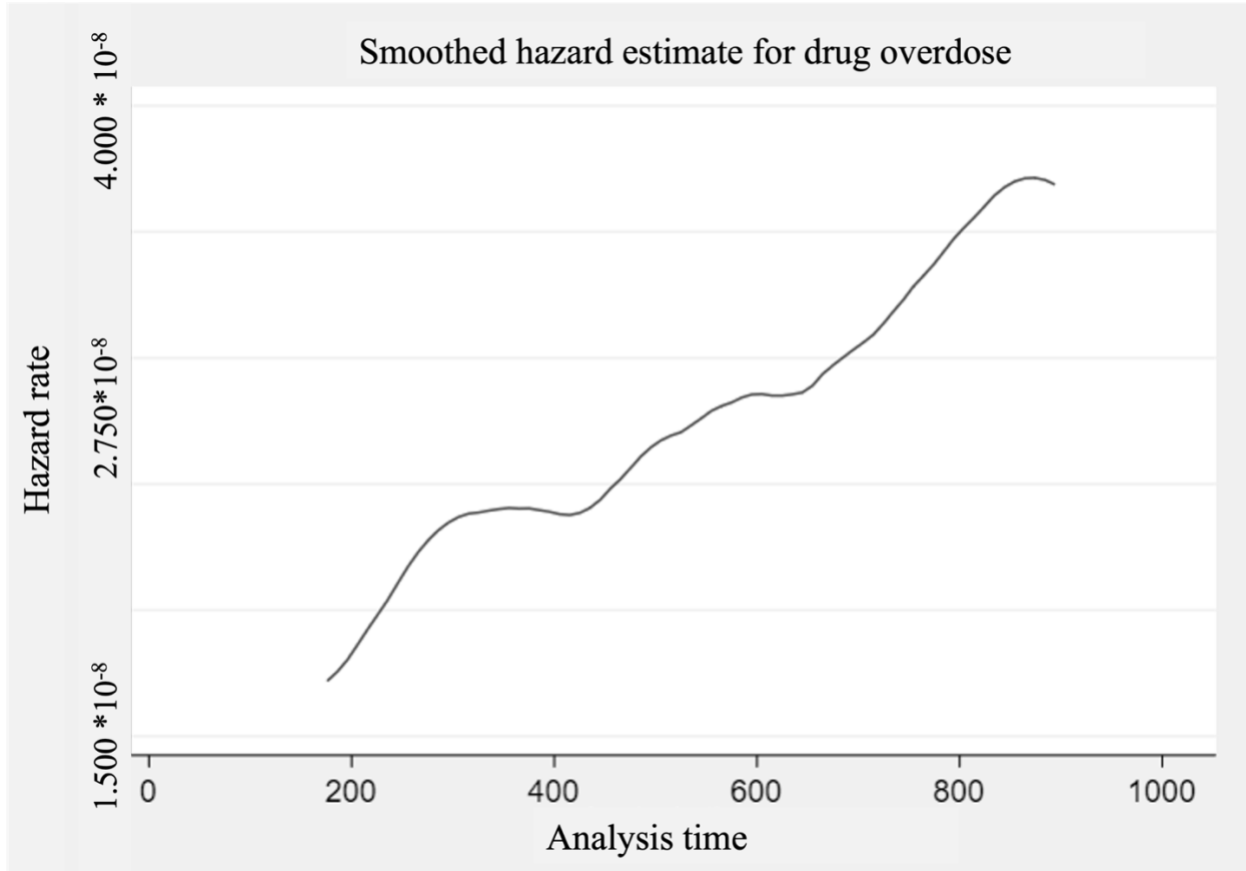
Table 6-1. Distribution of the sample characteristics at the baseline, Canadian Census 2006.

		Weighted *n*	%
Individual-level Characteristics			
Gender	Female	3759170[a]	48.67
	Male	3964135	51.32
Immigrant status	Non-immigrant	7105150	92.00
	Immigrant	618160	8.00
Income quintiles	Low	1383850	17.92
	Low-moderate	1530355	19.82
	Moderate	1581850	20.48
	Moderate-high	1606575	20.80
	High	1620680	20.98
Visible minority status	Non-visible minority	5788625	74.95
	Visible minority	1934685	25.05
		Weighted Mean	**Standard error**
Age		10.05	0.03
CD-level Characteristics			
After-tax Gini coefficient		0.38	0.01
% lone-parent households		0.16	0.01
% households with at least high school completed		0.40	0.01
Mean after-tax household income		58434.19	1575.78

[a] All frequencies are rounded based on Statistics Canada guidelines for vetting CanCHEC data from the Research Data Centre programme.

Table 6-2. Results from the unadjusted and adjusted multi-level survival models for the association between income inequality and

deaths of despair (n=1,140).

			Crude Model				Adjusted Model		
			Hazard ratio	p-value	Confidence interval		Hazard ratio	p-value	Confidence interval	
Fixed effects	z-transformed Gini coefficient		1.78	<0.001	1.37	2.31	1.35	0.024	1.04	1.75
	Age	In years					1.34	< 0.001	1.28	1.40
	Gender (ref: female)	Male					3.00	< 0.001	1.95	4.62
	Visible minority status (ref: non-visible minority)	Visible minority					1.69	0.054	0.99	2.88
	Immigrant status (ref: non-immigrant)	Immigrant					0.29	0.008	0.11	0.72
	Income (ref: low income)	Low-moderate					0.85	0.34	0.61	1.18
		Moderate					0.47	0.001	0.30	0.73
		Moderate-high					0.42	0.001	0.25	0.70
		High					0.44	< 0.001	0.30	0.66
	z-transformed % lone parent						1.55	0.001	1.20	2.00
	z-transformed % educated						1.54	0.004	1.15	2.08
	z-transformed after-tax mean household income						1.68	< 0.001	1.28	2.21
Random effects										
	Random intercept		4.45		3.26	6.09	3.39		2.42	4.75

Table 6-3. Results from the unadjusted and adjusted multi-level survival models for the association between income inequality and suicide (n=205).

			Unadjusted Model				Adjusted Model			
			Hazard ratio	p-value	Confidence interval		Hazard ratio	p-value	Confidence interval	
					Lower bound	Upper bound			Lower bound	Upper bound
Fixed effects	z-transformed Gini coefficient		1.683	< 0.001	1.274	2.224	1.22	0.164	0.92	1.62
	Age	In years					1.33	<0.001	1.27	1.39
	Gender (ref: female)	Male					3.08	<0.001	1.81	5.25
	Visible minority status (ref: non-visible minority)	Visible minority					2.27	0.008	1.24	4.18
	Immigrant status (ref: non-immigrant)	Immigrant					0.11	0.006	0.02	0.53
	Income (ref: low income)	Low-moderate					1.05	0.794	0.71	1.56
		Moderate					0.59	0.049	0.35	1.00
		Moderate-high					0.58	0.047	0.34	0.99
		High					0.60	0.034	0.37	0.96
	z-transformed % lone parent						1.63	0.001	1.23	2.16

z-transformed % educated			1.66	0.002	1.21	2.27
z-transformed after-tax mean household income			1.76	< 0.001	1.32	2.34
Random effects						
Random intercept	0.93	4.14	7.87		2.85	5.79

Table 6-4. Results from the unadjusted and adjusted multi-level survival models for the association between income inequality and drug overdose (n=930).

			Unadjusted Model				Adjusted Model			
			Hazard ratio	p-value	Confidence interval		Hazard ratio	p-value	Confidence interval	
					Lower bound	Upper bound			Lower bound	Upper bound
Fixed effects	z-transformed Gini coefficient		2.66	<0.001	1.88	3.77	2.39	<0.001	1.64	3.49
	Age	In years					1.39	<0.001	1.19	1.63
	Gender (ref: female)	Male					2.59	0.002	1.44	4.69
	Visible minority status (ref: non-visible minority)	Visible minority					0.36	0.078	0.12	1.12
	Immigrant status (ref: non-immigrant)	Immigrant					1.76	0.349	0.54	5.77
	Income (ref: low income)	Low-moderate					0.42	0.035	0.18	0.94
		Moderate					0.17	0.002	0.06	0.51
		Moderate-high					0.10	<0.001	0.03	0.31
		High					0.15	<0.001	0.06	0.37
	z-transformed % lone parent						1.33	0.195	0.86	2.05

z-transformed % educated					1.08	0.784	0.61	1.94
z-transformed after-tax mean household income					1.48	<0.001	1.66	2.36
Random effects								
	Random intercept	4.31	2.72	6.83	4.54		2.82	7.33

Table 6-5. Results from the unadjusted and adjusted multi-level survival models for the association between income inequality and all-cause death (n=38,005).

			Unadjusted Model				Adjusted Model			
			Hazard ratio	p-value	Confidence interval		Hazard ratio	p-value	Confidence interval	
					Lower bound	Upper bound			Lower bound	Upper bound
Fixed effects	z-transformed Gini coefficient		1.16	0.001	1.06	1.26	1.11	0.002	1.04	1.18
	Age	In years					1.11	< 0.001	1.10	1.12
	Gender (ref: female)	Male					2.06	< 0.001	1.95	2.17
	Visible minority status (ref: non-visible minority)	Visible minority					1.27	< 0.001	1.11	1.45
	Immigrant status (ref: non-immigrant)	Immigrant					0.60	< 0.001	0.53	0.68
	Income (ref: low income)	Low-moderate					0.80	< 0.001	0.75	0.86
		Moderate					0.66	< 0.001	0.60	0.73
		Moderate-high					0.56	< 0.001	0.50	0.62
		High					0.52	< 0.001	0.48	0.57
	z-transformed % lone parent						1.12	0.001	1.05	1.20
	z-transformed % educated						1.31	< 0.001	1.24	1.39
	z-transformed after-tax						1.16	< 0.001	1.10	1.22

	mean household income							
Random effects								
	Random intercept	0.33	0.26	0.41	0.19		0.15	0.25

Chapter 7: Conclusion

The overarching goals of this doctoral thesis are to quantify the association between income inequality and adolescent mental health and deaths attributable to drug overdose and all-cause mortality. Discussion of the findings of the four articles outlined in this thesis, as well as the next steps for future research and public health significance will be discussed in the following paragraphs.

Main findings

Ultimately, the results of this work show that income inequality is associated with depression in adolescents over time (article 1, objective 1), psycho-social well-being as the indicator of depression in adolescents (article 2, objective 2), changes in anxiety associated with the COVID-19 pandemic in adolescents (article 3, objective 3), and increases in hazard of deaths of despair, drug overdose, and all-cause death in youth (article 4, objective 4). According to results from the linear mixed models employed in objective 1, CD-level income inequality remained associated with an increase in z-transformed adolescent depressive scores (ß=0.08; 95% CI = 0.02, 0.14) and was not significantly associated with a change in z-transformed adolescent anxiety scores. As per the results from the multi-level path analysis employed to assess objective 2, students attending schools in CDs with higher income inequality reported higher depression scores among Canadian secondary students (β = 5.36; 95% CI = 0.74, 9.99) and lower psychosocial well-being (β = -14.83, 95% CI = -25.05, -4.60). For objective 3, adjusted, linear mixed models demonstrated that the association between income inequality and anxiety scores was significantly exacerbated following the onset of COVID-19 (β =0.02, 95% CI=0.0004, 0.03), indicating that income inequality was associated with a greater increase in anxiety scores during COVID-19, as compared to before COVID-19. Finally, the results of

assessing objective 4 of this thesis showed that a SD-unit increase in Gini Coefficient was associated with an increase in the hazard ratio for deaths of despair [adjusted hazard ratio (aHR): 1.35; 95% CI: 1.04, 1.75], drug overdose (aHR: 2.38; 95% CI: 1.63, 3.48), and all-cause deaths (aHR: 1.10; 95% CI: 1.04, 1.18).

Broadly, this thesis quantifies associations between income inequality and mental health and risk for deaths of despair in youth. However, the evidence put forward in this thesis should not be interpreted as causal, but as a marker that inequalities may contribute to such outcomes. Several other explanations may underlie the link between income inequality and mental health. For example, income inequality may be a great contributor to wealth inequalities, such that the income an individual earns may contribute to their overall wealth, which may also be composed of generational earnings or value of personal belongings (Saez, 2017). Income adds to wealth but is one small piece of wealth and a body of research suggestions wealth inequality can be harmful to population health and widen health disparities (Carson, 2009; Diez Roux, 2021; Nowatzki, 2012). Further, as suggested by Coburn (Coburn, 2004), neoliberalism may be a more likely contributor to health and mental health, rather than income inequality. However, a collection of literature suggests that neoliberalist policies drive income inequality (Huber & Solt, 2004; Koechlin, 2013). Despite conflicting reports (Crouch, 2022; Šumonja, 2021), neoliberalist policies appear stagnant even in light of world-changing events (e.g., the COVID-19 pandemic). If neoliberalism is unlikely to waver, reducing the burden of income inequality is still one feasible way to improve health and mental health. As such, this thesis provides support to a body of literature highlighting associations between income inequality and population health and, in the following sections, provides recommendations for future research and interventions to reduce the burden of income inequality.

How this thesis fills gaps in the social determinants of mental health framework

The results from this thesis contribute to current knowledge regarding the social determinants of mental health, providing estimates of risk regarding the association between income inequality and mental health. The work outlined in this thesis incorporates both proximal determinants of health and coping behaviours that are highlighted within the social determinants of mental health framework. This work has the potential to advance scientific inquiry related to this framework by filling gaps highlighted by users of this framework (Alegría et al., 2018). For example, Objectives 1, 3, and 4 of this thesis draw upon recommendation two as per Alegría and colleagues (2018) to use longitudinal data to distill temporal relationships as relating to the social determinants of mental health. Further, all studies included in this thesis have recommendation four, as proposed by Alegría and colleagues (2018), by studying associations specifically among youth, who are particularly vulnerable to the effects of income inequality and poor mental health (Kutcher & Venn, 2008). Although this study addresses some gaps in the social determinants of mental health framework, future applications should incorporate interplay between the determinants of health (Alegría et al., 2018). Notably, future research may further investigate how income inequality contributes to mental health among other vulnerable groups (e.g., by gender, race/ethnicity, or sexual orientation). These recommendations align with research calls that highlight a need for studies on income inequality within marginalized sub-groups (Dunn et al., 2022). Per Algeria and colleagues (2018), researchers may also consider using simulation-based techniques and strengthen existing evidence and predict the impact of future interventions, assessing the potential for further stigmatization of vulnerable groups, the development and evaluation of multi-pronged interventions for addressing multiple determinants of health, and improving dissemination for policymakers, patients, and clinicians alike with the aim of

increasing responsibility of decision-makers in improving population mental health. The following section of this thesis elaborates on specific recommendations for future research.

Considerations for future research

Despite the novel findings of the research outlined in this dissertation, several considerations should be made in future research. Each chapter of this thesis has highlighted limitations of not only what existed regarding income inequality and youth mental health and deaths of despair prior to this work, but also limitations of this thesis work itself. This section will highlight proposed directions for future research. For example, future studies should consider if there are key subgroups that experiences worse outcomes associated with income inequality. For example, those with mental health concerns may be at an increased risk of deaths attributable to suicide and overdose as associated with income inequality compared to those without mental health conditions. Further, future analyses may consider moderating effects of race/ethnicity, as some research indicates that income inequality is associated with increased risk of mortality specifically in spaces with higher visible minority populations (D. K. McLaughlin & Stokes, 2002).

The use of cross-sectional data to quantify the relationship between income inequality, psychosocial wellbeing and social cohesion, and depression is not recommended for future research. Repeated measures of the exposure, covariates, and outcome data may aid in identifying changes in these predictors over time and to determine if they remain significant predictors of depression. Such analyses would provide stronger evidence of an association and potentially for causality. Moreover, quasi-experimental study designs should be used to assess similar research questions. Researchers may, for example, evaluate the effects of minimum wage increases on adolescent mental health and deaths of despair. Further, methods such as propensity

score matching, inverse-probability weighting, and instrumental variables may be used to strengthen causal claims introduced in observational research.

Public health significance

The findings of this thesis work have potential implications for public health. The results indicated that there is an association between income inequality and adolescent mental health and deaths of despair. Thus, improved monitoring of adolescent mental health, substance use, and levels of income inequality is necessary. Further, the findings from this thesis highlight a need for policies and programming to reduce income inequality and the harmful factors associated with higher income inequality. Policies and programs for reducing income inequality may include, but not be limited to, cash transfer programs, Universal Basic Income programs, and increases to minimum wage policies (Benny, Yamamoto, et al., 2022; Horrigan & Mincy, 1999; Ruckert et al., 2018); whereas policies and programs for improving youth mental health may include increased counselling availability and referrals for mental health services, substance use prevention and, likewise, harm reduction programs (Cuijpers, 2002; Leslie et al., 2008; Wiens et al., 2020). Based on the findings outlined in this thesis, it stands to reason that some income inequality reducing programs may also have beneficial, downstream contributions to the risk of adverse mental health in teams.

Notably, the findings from article 1 highlight a potential need for increased mental health, and specifically depression-related support in schools in higher income inequality areas. Further, the findings of article 2 emphasize the need for programming related to psychosocial well-being, for example, programs that may improve self-esteem and self-efficacy among students to reduce the burden of depression in secondary schools. The results from article 3 call attention to the need for additional supports for anxiety in secondary school students as the COVID-19 pandemic

continues. Finally, the findings from article 4 show a need for population-based approaches for reducing income inequality and subsequent deaths of despair within the Canadian context. In its entirety, this work has implications for discussions regarding adolescent mental health and substance use. While adolescent mental health and substance use are important public health concerns, deaths associated with adverse mental health and poisoning by substances are also major concerns. Such policies and health promotion strategies can help reduce or prevent adolescent depression, anxiety, and substance use in Canada. Also, by identifying areas with greater levels of income inequality, it becomes easier to identify particularly high-risk areas for targeted programming. More research is necessary to determine the strength of the association between income inequality, mental health, and substance; however, this work is a foundational step in reducing social inequities and their apparent contributions to adolescent well-being.

Complete Dissertation Bibliography

Abedi, M. (2017). Rise of income inequality in Canada 'almost exclusive' to major cities: study. *Global News*. https://globalnews.ca/news/3599083/income-inequality-canada-cities/

Abrams, K., Theberge, S. K., & Karan, O. C. (2005). Children and adolescents who are depressed: An ecological approach. *Professional School Counseling*, *8*(3), 282–292.

Aguirre Velasco, A., Cruz, I. S. S., Billings, J., Jimenez, M., & Rowe, S. (2020). What are the barriers, facilitators and interventions targeting help-seeking behaviours for common mental health problems in adolescents? A systematic review. *BMC Psychiatry*, *20*(1), 293. https://doi.org/10.1186/s12888-020-02659-0

Akhtar-Danesh, N., & Landeen, J. (2007). Relation between depression and sociodemographic factors. *International Journal of Mental Health Systems*, *1*, 1–9. https://doi.org/10.1186/1752-4458-1-4

Alegría, M., NeMoyer, A., Falgàs Bagué, I., Wang, Y., & Alvarez, K. (2018). Social determinants of mental health: where we are and where we need to go. *Current Psychiatry Reports*, *20*(11), 1–13.

Alesina, A., & Perotti, R. (1996). Income distribution, political instability, and investment. *European Economic Review*, *40*(6), 1203–1228.

Allen, J., Balfour, R., Bell, R., & Marmot, M. (2014). Social determinants of mental health. *International Review of Psychiatry*, *26*(4), 392–407.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

Andresen, E. M., Malmgren, J. A., Carter, W. B., & Patrick, D. L. (1994). Screening for depression in well older adults: Evaluation of a short form of the CES-D. *American Journal*

of Preventive Medicine, *10*(2), 77–84.

Auger, N., Hamel, D., Martinez, J., & Ross, N. A. (2012). Mitigating effect of immigration on the relation between income inequality and mortality: a prospective study of 2 million Canadians. *J Epidemiol Community Health*, *66*(6), e5–e5.

Auger, N., Zang, G., & Daniel, M. (2009). Community-level income inequality and mortality in Québec, Canada. *Public Health*, *123*(6), 438–443.

Austin, P. C. (2017). A Tutorial on Multilevel Survival Analysis: Methods, Models and Applications. *International Statistical Review = Revue Internationale de Statistique*, *85*(2), 185–203. https://doi.org/10.1111/insr.12214

Baker, E. H. (2014). Socioeconomic status, definition. *The Wiley Blackwell Encyclopedia of Health, Illness, Behavior, and Society*, 2210–2214.

Bartram, M. (2019). Income-based inequities in access to mental health services in Canada. *Canadian Journal of Public Health*, *110*(4), 395–403.

Battista, K., Qian, W., Bredin, C., & Leatherdale, S. T. (2019). *Student Data Linkage over Multiple Years. Technical Report Series: 6(3)*.

Beesdo, K., Knappe, S., & Pine, D. S. (2009). Anxiety and anxiety disorders in children and adolescents: developmental issues and implications for DSM-V. *Psychiatric Clinics*, *32*(3), 483–524.

Belle, D., & Doucet, J. (2003). Poverty, inequality, and discrimination as sources of depression among US women. *Psychology of Women Quarterly*, *27*(2), 101–113.

Benny, C., Patte, K. A., Veugelers, P., Leatherdale, S. T., & Pabayo, R. (2022). Income inequality and depression among Canadian secondary students: Are psychosocial well-being and social cohesion mediating factors? *SSM-Population Health*, *17*, 100994.

Benny, C., Yamamoto, S., McDonald, S., Chari, R., & Pabayo, R. (2022). Modelling Maternal

Depression: An Agent-Based Model to Examine the Complex Relationship between

Relative Income and Depression. *International Journal of Environmental Research and*

Public Health, *19*(7), 4208.

Berkman, Lisa F, Kawachi, I., & Glymour, M. M. (2014). *Social epidemiology*. Oxford

University Press.

Blakely, T. A., Kennedy, B. P., Glass, R., & Kawachi, I. (2000). What is the lag time between

income inequality and health status? *Journal of Epidemiology & Community Health*, *54*(4),

318–319.

Breau, S. (2014). L'inégalité des revenus au Canada. *Nouvelles Perspectives En Développement*

Régional: Essais En l'honneur de Donald J. Savoie.

Burns, J. K., Tomita, A., & Lund, C. (2017). Income inequality widens the existing income-

related disparity in depression risk in post-apartheid South Africa: Evidence from a

nationally representative panel study. *Health & Place*, *45*, 10–16.

https://doi.org/10.1016/j.healthplace.2017.02.005

Buttrick, N., & Oishi, S. (2017). The psychological consequences of income inequality. *Soc Pers*

Psychol Compass, *11*, e12304.

Cameron, J. J., & Stinson, D. A. (2017). *Encyclopedia of Personality and Individual Differences*

(V. Zeigler-Hill & T. K. Shackelford (eds.); pp. 1–6). Springer International Publishing.

https://doi.org/10.1007/978-3-319-28099-8_1187-1

Canadian Institute for Health Information. (2019). *OECD Interactive Tool: International*

Comparisons — Peer countries. OECD Tool. https://www.cihi.ca/en/oecd-interactive-tool-

peer-countries-on

Canadian Mental Health Association. (2014). *Fast Facts about Mental Illness*.

Carnes, N. (2020). *The Cash Ceiling: Why Only the Rich Run for Office--and What We Can Do About It* (Vol. 16). Princeton University Press.

Carson, S. A. (2009). Health, Wealth, and Inequality: A Contribution to the Debate about the Relationship between Inequality and Health. *Historical Methods: A Journal of Quantitative and Interdisciplinary History*, *42*(2), 43–56. https://doi.org/10.3200/HMTS.42.2.43-56

Case, A., & Deaton, A. (2015). Rising morbidity and mortality in midlife among white non-Hispanic Americans in the 21st century. *Proceedings of the National Academy of Sciences*, *112*(49), 15078–15083.

Chadi, N., Spinoso-Di Piano, C., Osmanlliu, E., Gravel, J., & Drouin, O. (2021). Mental Health–Related Emergency Department Visits in Adolescents Before and During the COVID-19 Pandemic: A Multicentric Retrospective Study. *Journal of Adolescent Health*, *69*(5), 847–850. https://doi.org/https://doi.org/10.1016/j.jadohealth.2021.07.036

Cheung, A. H., & Dewa, C. S. (2006). Canadian Community Health Survey: Major depressive disorder and suicidality in adolescents. *Healthcare Policy = Politiques de Sante*, *2*(2), 76–89.

Chiavegatto Filho, A. D. P., Kawachi, I., Wang, Y. P., Viana, M. C., & Andrade, L. H. S. G. (2013). Does income inequality get under the skin? A multilevel analysis of depression, anxiety and mental disorders in Sao Paulo, Brazil. *Journal of Epidemiology and Community Health*, *67*(11), 966–972. https://doi.org/10.1136/jech-2013-202626

Children's Commisioner for England. (2016). *Lightning Review: Access to Child and Adolescent Mental Health Services*.

Choma, B. L., Ashton, M. C., & Hafer, C. L. (2010). Conceptualizing political orientation in

Canadian political candidates: A tale of two (correlated) dimensions. *Canadian Journal of Behavioural Science/Revue Canadienne Des Sciences Du Comportement*, *42*(1), 24.

Coburn, D. (2000). Income inequality, social cohesion and the health status of populations: the role of neo-liberalism. *Social Science & Medicine*, *51*(1), 135–146.

Coburn, D. (2004). Beyond the income inequality hypothesis: class, neo-liberalism, and health inequalities. *Social Science & Medicine*, *58*(1), 41–56. https://doi.org/https://doi.org/10.1016/S0277-9536(03)00159-X

Cochrane. (2019). *Covidence*. Cochrane.

Cochrane, C. (2010). Left/Right Ideology and Canadian Politics—ERRATUM. *Canadian Journal of Political Science/Revue Canadienne de Science Politique*, *43*(4), 1007–1008.

Costello, E. J., Egger, H., & Angold, A. (2005). 10-year research update review: the epidemiology of child and adolescent psychiatric disorders: I. Methods and public health burden. *Journal of the American Academy of Child and Adolescent Psychiatry*, *44*(10), 972–986. https://doi.org/10.1097/01.chi.0000172552.41596.6f

Craig, S. G., Ames, M. E., Bondi, B. C., & Pepler, D. J. (2022). Canadian adolescents' mental health and substance use during the COVID-19 pandemic: Associations with COVID-19 stressors. In *Canadian Journal of Behavioural Science / Revue canadienne des sciences du comportement* (p. No Pagination Specified-No Pagination Specified). Educational Publishing Foundation. https://doi.org/10.1037/cbs0000305

Crouch, C. (2022). Reflections on the COVID moment and life beyond neoliberalism. *Transfer: European Review of Labour and Research*, *28*(1), 31–45. https://doi.org/10.1177/10242589221078125

Cuijpers, P. (2002). Effective ingredients of school-based drug prevention programs. A

systematic review. *Addictive Behaviors*, *27*(6), 1009–1023.

Curtis, A. (2015). Defining adolescence. *Journal of Adolescent and Family Health*, *7*(2), 1–40. https://doi.org/10.1037/000574

Dabravolskaj, J., Khan, M., Veugelers, P., & Maximova, K. (2021). Mental Health and Wellbeing of 9–12-year-old Children in Northern Canada Before the COVID-19 Pandemic and After the First Lockdown . In *International Journal of Public Health* (Vol. 66). https://www.ssph-journal.org/articles/10.3389/ijph.2021.1604219

De Maio, F. G. (2007). Income inequality measures. *Journal of Epidemiology & Community Health*, *61*(10), 849–852.

De Maio, F. G. (2014). Income Inequality Hypothesis. In *The Wiley Blackwell Encyclopedia of Health, Illness, Behavior, and Society* (pp. 1223–1228). https://doi.org/doi:10.1002/9781118410868.wbehibs312

Dietze, P. M., Jolley, D. J., Chikritzhs, T. N., Clemens, S., Catalano, P., & Stockwell, T. (2009). Income inequality and alcohol attributable harm in Australia. *BMC Public Health*, *9*(1), 1–9.

Diez Roux, A. V. (2004). The Study of Group-Level Factors in Epidemiology: Rethinking Variables, Study Designs, and Analytical Approaches. *Epidemiologic Reviews*, *26*(1), 104–111. https://doi.org/10.1093/epirev/mxh006

Diez Roux, A. V. (2021). The Pervasive Influence of Wealth Inequality on Health. *JAMA Health Forum*, *2*(7), e211647–e211647. https://doi.org/10.1001/jamahealthforum.2021.1647

DiLalla, L. F. (2000). Structural equation modeling: Uses and issues. In *Handbook of applied multivariate statistics and mathematical modeling* (pp. 439–464). Elsevier.

Dow, W. H., Godøy, A., Lowenstein, C., & Reich, M. (2020). Can Labor Market Policies

Reduce Deaths of Despair? *Journal of Health Economics*, *74*, 102372. https://doi.org/https://doi.org/10.1016/j.jhealeco.2020.102372

Dowell, D., Noonan, R. K., & Houry, D. (2017). Underlying factors in drug overdose deaths. *Jama*, *318*(23), 2295–2296.

Dressler, W. W., Balieiro, M. C., & dos Santos, J. E. (2017). Cultural consonance in life goals and depressive symptoms in urban Brazil. *Journal of Anthropological Research*, *73*(1), 43–65.

Duca, J. V, & Saving, J. L. (2016). Income inequality and political polarization: Time series evidence over nine decades. *Review of Income and Wealth*, *62*(3), 445–466.

Dunn, J. R., Park, G.-R., Brydon, R., Wolfson, M., Veall, M., Rolheiser, L., Siddiqi, A., & Ross, N. A. (2022). Income inequality and population health: a political-economic research agenda. *J Epidemiol Community Health*.

Dutt, A. K. (1984). Stagnation, income distribution and monopoly power. *Cambridge Journal of Economics*, *8*(1), 25–40.

Edlund, J., & Lindh, A. (2015). The democratic class struggle revisited: the welfare state, social cohesion and political conflict. *Acta Sociologica*, *58*(4), 311–328.

Eibner, C., Sturn, R., & Gresenz, C. R. (2004). Does relative deprivation predict the need for mental health services. *J Ment Health Policy Econ*, *7*(4), 167–175.

Esposito-Smythers, C., & Spirito, A. (2004). Adolescent substance use and suicidal behavior: a review with implications for treatment research. *Alcoholism, Clinical and Experimental Research*, *28*(5 Suppl), 77S-88S.

Falk, I., Kilpatrick, S., & Tasmania Univ., L. (Australia). C. for R. and L. in R. A. (1999). *What Is Social Capital? A Study of Interaction in a Rural Community*.

https://login.ezproxy.library.ualberta.ca/login?url=https://search.ebscohost.com/login.aspx?
direct=true&db=eric&AN=ED444776&site=eds-live&scope=site

Fan, A. Z., Strasser, S., Zhang, X., Dhingra, S., Mcknight-eily, L., Holt, J., & Balluz, L. (2011).
State-level socioeconomic factors are associated with current depression among U . S .
adults in 2006 and 2008. *Journal of Public Health and Epidemiology*, *3*(10), 462–470.
http://www.academicjournals.org/JPHE

Fernquist, R. M. (2003). Perceived income inequality and suicide rates in Central/Eastern
European countries and Western countries, 1990-1993. In *Death Studies* (Vol. 27, Issue 1,
pp. 63–80). Taylor & Francis. https://doi.org/10.1080/07481180302870

Fisher, M., & Baum, F. (2010). The social determinants of mental health: implications for
research and health promotion. *Australian & New Zealand Journal of Psychiatry*, *44*(12),
1057–1063.

Fone, D., White, J., Farewell, D., Kelly, M., John, G., Lloyd, K., Williams, G., & Dunstan, F.
(2014). Effect of neighbourhood deprivation and social cohesion on mental health
inequality: a multilevel population-based longitudinal study. *Psychological Medicine*,
44(11), 2449–2460. https://doi.org/10.1017/S0033291713003255

Galea, S., Ahern, J., Vlahov, D., Coffin, P. O., Fuller, C., Leon, A. C., & Tardiff, K. (2003).
Income distribution and risk of fatal drug overdose in New York City neighborhoods. *Drug
and Alcohol Dependence*, *70*(2), 139–148. https://doi.org/10.1016/s0376-8716(02)00342-3

Gentilini, U., Grosh, M., Rigolini, J., & Yemtsov, R. (2019). *Exploring universal basic income:
A guide to navigating concepts, evidence, and practices*. World Bank Publications.

Gerber, J. P., Wheeler, L., & Suls, J. (2018). A social comparison theory meta-analysis 60+ years
on. In *Psychological Bulletin* (Vol. 144, Issue 2, pp. 177–197). American Psychological

Association. https://doi.org/10.1037/bul0000127

Global Burden of Disease. (2013). GBD Compare. *Seattle: University of Washington*.

Global Burden of Disease. (2016). *Global Burden of Disease 2016: Mental disorders < 20 years of age*. Institute for Health Metrics and Evaluation. https://vizhub.healthdata.org/gbd-compare/

Goodman, E., Huang, B., Wade, T. J., & Kahn, R. S. (2003). A multilevel analysis of the relation of socioeconomic status to adolescent depressive symptoms: does school context matter? *The Journal of Pediatrics*, *143*(4), 451–456. https://doi.org/https://doi.org/10.1067/S0022-3476(03)00456-6

Grimes, D. A., & Schulz, K. F. (2002). Bias and causal associations in observational research. *The Lancet*, *359*(9302), 248–252. https://doi.org/10.1016/S0140-6736(02)07451-2

Grimm, P. (2010). Social Desirability Bias. In *Wiley International Encyclopedia of Marketing*.

Gu, Y., & Wang, Z. (2022). Income Inequality and Global Political Polarization: The Economic Origin of Political Polarization in the World. *Journal of Chinese Political Science*, *27*(2), 375–398. https://doi.org/10.1007/s11366-021-09772-1

Handa, S., Daidone, S., Peterman, A., Davis, B., Pereira, A., Palermo, T., & Yablonski, J. (2018). Myth-busting? Confronting six common perceptions about unconditional cash transfers as a poverty reduction strategy in Africa. *The World Bank Research Observer*, *33*(2), 259–298.

Haroz, E. E., Ybarra, M. L., & Eaton, W. W. (2014). Psychometric evaluation of a self-report scale to measure adolescent depression: the CESDR-10 in two national adolescent samples in the United States. *Journal of Affective Disorders*, *158*, 154–160.

Harris, E. C., & Barraclough, B. (1998). Excess mortality of mental disorder. *The British Journal*

of Psychiatry : The Journal of Mental Science, *173*, 11–53.

Hawton, K., i Comabella, C. C., Haw, C., & Saunders, K. (2013). Risk factors for suicide in individuals with depression: a systematic review. *Journal of Affective Disorders*, *147*(1–3), 17–28.

Heflin, C. M., & Iceland, J. (2009). Poverty, material hardship, and depression. *Social Science Quarterly*, *90*(5), 1051–1071.

Herge, W. M., Landoll, R. R., & La Greca, A. M. (2013). *Center for Epidemiologic Studies Depression Scale (CES-D) BT - Encyclopedia of Behavioral Medicine* (M. D. Gellman & J. R. Turner (eds.); pp. 366–367). Springer New York. https://doi.org/10.1007/978-1-4419-1005-9_732

Higgins, J. P. T., & Green, S. (2011). *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]*. The Cochrane Collaboration.

Horrigan, M., & Mincy, R. (1999). The minimum wage and earnings and income inequality. In *Uneven tides: Rising inequality in America* (pp. 251–275).

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Huber, E., & Solt, F. (2004). Successes and failures of neoliberalism. *Latin American Research Review*, *39*(3), 150–164.

Hulchanski, J. D., & Murdie, R. A. (2013). *Canada's Income Polarization Trend: An International and a Four Metropolitan Area Comparison. A brief submitted to the House of Commons Standing Committee on Finance for its study on income inequality in Canada, 5 April 2013*.

Irvine, M. A., Kuo, M., Buxton, J. A., Balshaw, R., Otterstatter, M., Macdougall, L., Milloy, M.-J., Bharmal, A., Henry, B., Tyndall, M., Coombs, D., & Gilbert, M. (2019). Modelling the combined impact of interventions in averting deaths during a synthetic-opioid overdose epidemic. *Addiction*, *114*(9), 1602–1613. https://doi.org/https://doi.org/10.1111/add.14664

Jackson, P. (1983). Inequality, Opportunity, and Crime Rates in Central Cities. *Criminology*, *21*(2), 178–194. https://doi.org/10.1111/j.1745-9125.1983.tb00257.x

Jahan, A., Tyagi, N., & Suri, S. (2015). Income disparity as a predictor of happiness and self-esteem. *The International Journal of Indian Psychology*, *3*(1), 149–156.

Jenson, J., & Saint-Martin, D. (2003). New routes to social cohesion? Citizenship and the social investment state. *Canadian Journal of Sociology/Cahiers Canadiens de Sociologie*, 77–99.

Johnson, S. L., Leedom, L. J., & Muhtadie, L. (2012). The dominance behavioral system and psychopathology: Evidence from self-report, observational, and biological studies. *Psychological Bulletin*, *138*(4), 692.

Johnson, T. P. (2014). Sources of error in substance use prevalence surveys. *International Scholarly Research Notices*, *2014*, 1–21. https://doi.org/10.1155/2014/923290

Kalin, N. H. (2020). The Critical Relationship Between Anxiety and Depression. *American Journal of Psychiatry*, *177*(5), 365–367. https://doi.org/10.1176/appi.ajp.2020.20030305

Kaufman, J. A., Salas-Hernández, L. K., Komro, K. A., & Livingston, M. D. (2020). Effects of increased minimum wages by unemployment rate on suicide in the USA. *J Epidemiol Community Health*, *74*(3), 219–224.

Kawachi, I, & Kennedy, B. (1999). Income inequality and health: pathways and mechanisms. *Health Services Research*, *34*(1 pt 2), 215–227.

Kawachi, Ichiro, & Berkman, L. (2000). Social cohesion, social capital, and health. *Social*

Epidemiology, *174*(7), 290–319.

Kawachi, Ichiro, & Kennedy, B. P. (1997). Socioeconomic determinants of health: Health and social cohesion: why care about income inequality? *Bmj*, *314*(7086), 1037.

Kawachi, Ichiro, Kennedy, B. P., Lochner, K., & Prothrow-stith, D. (1997). Social capital, income inequality, and mortality. *American Journal of Public Health*, *87*(9), 1491–1498.

Kawachi, Ichiro, Levine, S., Miller, S. M., Lasch, K., & Amick III, B. C. (1994). *Income inequality and life expectancy: Theory, research, and policy*.

Kessler, R. C., Amminger, G. P., Aguilar-Gaxiola, S., Alonso, J., Lee, S., & Ustün, T. B. (2007). Age of onset of mental disorders: a review of recent literature. *Current Opinion in Psychiatry*, *20*(4), 359–364. https://doi.org/10.1097/YCO.0b013e32816ebc8c

Kessler, R. C., & Wang, P. S. (2008). The descriptive epidemiology of commonly occurring mental disorders in the United States. *Annual Review of Public Health*, *29*, 115–129. https://doi.org/10.1146/annurev.publhealth.29.020907.090847

Kim, I.-H., Muntaner, C., Shahidi, F. V., Vives, A., Vanroelen, C., & Benach, J. (2012). Welfare states, flexible employment, and health: a critical review. *Health Policy*, *104*(2), 99–127.

Kim, Y., & Hagquist, C. (2018). Trends in adolescent mental health during economic upturns and downturns: a multilevel analysis of Swedish data 1988-2008. *J Epidemiol Community Health*, *72*(2), 101–108.

Knoll, A. D., & MacLennan, R. N. (2017). Prevalence and correlates of depression In Canada: Findings from the Canadian Community Health Survey. *Canadian Psychology*, *58*(2), 116–123. https://doi.org/=

Koechlin, T. (2013). The rich get richer: neoliberalism and soaring inequality in the United States. *Challenge*, *56*(2), 5–30.

Kutcher, S., & Venn, D. (2008). Why youth mental health is so important. *Medscape Journal of Medicine*, *10*(12), 275. https://pubmed.ncbi.nlm.nih.gov/19242581

Leatherdale, S., Brown, K., Carson, V., Childs, R., Dubin, J., Elliot, S., Faulkner, G., Hammond, D., Manske, S., Sabiston, C., Laxer, R., Bredin, C., & Thompson-Haile, A. (2014). The COMPASS study: a longitudinal hierarchical research platform for evaluating natural experiments related to changes in school-level programs, policies and built environment resources. *BMC Public Health*, *14*, 331.

Lee, Y., Lui, L. M. W., Chen-Li, D., Liao, Y., Mansur, R. B., Brietzke, E., Rosenblat, J. D., Ho, R., Rodrigues, N. B., Lipsitz, O., Nasri, F., Cao, B., Subramaniapillai, M., Gill, H., Lu, C., & McIntyre, R. S. (2021). Government response moderates the mental health impact of COVID-19: A systematic review and meta-analysis of depression outcomes across countries. *Journal of Affective Disorders*, *290*, 364–377. https://doi.org/https://doi.org/10.1016/j.jad.2021.04.050

Left Business Observer. (1993). *Gini says: measuring income inequality*.

Leigh, J. P. (1983). Direct and indirect effects of education on health. *Social Science & Medicine*, *17*(4), 227–234.

Leslie, K. M., Society, C. P., & Committee, A. H. (2008). Harm reduction: An approach to reducing risky health behaviours in adolescents. *Paediatrics & Child Health*, *13*(1), 53–56.

Lester, D. (1998). Suicide and homicide after the fall of communist regimes. *European Psychiatry*, *13*(2), 98–100.

Lewinsohn, P M, Rohde, P., Klein, D. N., & Seeley, J. R. (1999). Natural course of adolescent major depressive disorder: I. Continuity into young adulthood. *Journal of the American Academy of Child and Adolescent Psychiatry*, *38*(1), 56–63.

https://doi.org/10.1097/00004583-199901000-00020

Lewinsohn, Peter M, Rohde, P., & Seeley, J. R. (1998). Major depressive disorder in older

adolescents: prevalence, risk factors, and clinical implications. *Clinical Psychology Review*,

18(7), 765–794.

Lorant, V., Deliège, D., Eaton, W., Robert, A., Philippot, P., & Ansseau, M. (2003).

Socioeconomic inequalities in depression: a meta-analysis. *American Journal of*

Epidemiology, *157*(2), 98–112.

Lund, C., Breen, A., Flisher, A. J., Kakuma, R., Corrigall, J., Joska, J. A., Swartz, L., & Patel, V.

(2010). Poverty and common mental disorders in low and middle income countries: A

systematic review. *Social Science & Medicine*, *71*(3), 517–528.

Lynch, J., & Kaplan, G. (2000). Socioeconomic position. In L.F. Berkman & I. Kawachi (Eds.),

Social epidemiology (pp. 13–35). Oxford University Press.

Lynch, J. W., Smith, G. D., Kaplan, G. A., & House, J. S. (2000). Income inequality and

mortality: importance to health of individual income, psychosocial environment, or material

conditions. *BMJ (Clinical Research Ed.)*, *320*(7243), 1200–1204.

https://doi.org/10.1136/bmj.320.7243.1200

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling.

Methodology, *1*(3), 86–92.

MacPhee, A. R., & Andrews, J. J. W. (2006). Risk factors for depression in early adolescence.

Adolescence, *41*(163), 435–466.

http://prxy.lib.unbc.ca/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=a

9h&AN=23237388&site=ehost-live&scope=site

Marshall, S. K., Charles, G., Hare, J., Jr, P. J. J., & Stokl, M. (2005). Sheway's services for

substance using pregnant and parenting women: evaluating the outcomes for infants. *Canadian Journal of Community Mental Health*, *24*(1), 19–34. http://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=109845260&login.asp&site=ehost-live&scope=site

Masselink, M., Van Roekel, E., & Oldehinkel, A. J. (2018). Self-esteem in early adolescence as predictor of depressive symptoms in late adolescence and early adulthood: the mediating role of motivational and social factors. *Journal of Youth and Adolescence*, *47*(5), 932–946.

McEwan, K., Waddell, C., & Barker, J. (2007). Bringing children's mental health "out of the shadows." *Cmaj*, *176*(4), 471–472.

McIntyre, R. S., Cha, D. S., Soczynska, J. K., Woldeyohannes, H. O., Gallaugher, L. A., Kudlow, P., Alsuwaidan, M., & Baskaran, A. (2013). Cognitive deficits and functional outcomes in major depressive disorder: determinants, substrates, and treatment interventions. *Depression and Anxiety*, *30*(6), 515–527.

McLaughlin, D. K., & Stokes, C. S. (2002). Income inequality and mortality in US counties: does minority racial concentration matter? *American Journal of Public Health*, *92*(1), 99–104.

McLaughlin, K. A., Costello, E. J., Leblanc, W., Sampson, N. A., & Kessler, R. C. (2012). Socioeconomic status and adolescent mental disorders. *American Journal of Public Health*, *102*(9), 1742–1750.

McLay, R., & Ramos, H. (2021). Do Polarization Narratives Apply to Politics on the Periphery? The Case of Atlantic Canada. *Frontiers in Sociology*, *6*, 655880.

McNeish, D. (2017). Multilevel Mediation With Small Samples: A Cautionary Note on the Multilevel Structural Equation Modeling Framework. *Structural Equation Modeling: A*

Multidisciplinary Journal, *24*(4), 609–625. https://doi.org/10.1080/10705511.2017.1280797

McNeish, D. M., & Stapleton, L. M. (2016). The effect of small sample size on two-level model estimates: A review and illustration. *Educational Psychology Review*, *28*(2), 295–314.

Michaud, P.-A., & Fombonne, E. (2005). The ABCs of Adolescence: Common mental health problems. *Bmj*, *330*(7495), 835–838.

Microsoft Office. (2016). *Microsoft Excel* (No. 2016). Microsoft. https://products.office.com/en-ca/excel

Miller, J. R., Piper, T. M., Ahern, J., Tracy, M., Tardiff, K. J., Vlahov, D., & Galea, S. (2005). Income inequality and risk of suicide in New York City neighborhoods: a multilevel case-control study. *Suicide and Life-Threatening Behavior*, *35*(4), 448–459.

Mohtadi, S., & Castells-Quintana, D. (2021). The distributional dimension of the resource curse: Commodity price shocks and income inequality. *Structural Change and Economic Dynamics*, *59*, 63–78.

Moody, J., & White, D. R. (1999). *Social Cohesion and Embeddedness: A hierarchical conception of social groups*. unpublished manuscript, submitted to the AJS.

Morgan, R. L., Whaley, P., Thayer, K. A., & Schünemann, H. J. (2018). Identifying the PECO: A framework for formulating good questions to explore the association of environmental and other exposures with health outcomes. *Environment International*, *121*(August), 1027–1031.

Mossman, S. A., Luft, M. J., Schroeder, H. K., Varney, S. T., Fleck, D. E., Barzman, D. H., Gilman, R., DelBello, M. P., & Strawn, J. R. (2017). The Generalized Anxiety Disorder 7-item scale in adolescents with generalized anxiety disorder: Signal detection and validation. *Annals of Clinical Psychiatry : Official Journal of the American Academy of Clinical*

Psychiatrists, *29*(4), 227-234A. https://pubmed.ncbi.nlm.nih.gov/29069107

Muntaner, C., Eaton, W. W., Miech, R., & O'campo, P. (2004). Socioeconomic position and

major mental disorders. *Epidemiologic Reviews*, *26*(1), 53–62.

Muriaas, R. L. (2019). The political over-representation of the rich in the USA. *European*

Political Science, *18*(4), 729–730.

Murray, C. J., & Lopez, A. D. (1997). Global mortality, disability, and the contribution of risk

factors: Global Burden of Disease Study. *Lancet*, *349*(9063), 1436–1442.

https://doi.org/10.1016/S0140-6736(96)07495-8

Nandi, A., Galea, S., Ahern, J., Bucciarelli, A., Vlahov, D., & Tardiff, K. (2006). What explains

the association between neighborhood-level income inequality and the risk of fatal

overdose in New York City? *Social Science & Medicine (1982)*, *63*(3), 662–674.

https://doi.org/10.1016/j.socscimed.2006.02.001

NCCS for Environmental Health and Determinants of Health. (2001). Environmental Influences

on Population Mental Health Promotion for Children and Youth. In *Schulz & Northridge*.

http://nccph.ca/images/uploads/general/03_Environmental_MentalHealth_NCCPH_2017_E

N.pdf

Neale, M. C., & Kendler, K. S. (1995). Models of comorbidity for multifactorial disorders.

American Journal of Human Genetics, *57*(4), 935–953.

https://www.ncbi.nlm.nih.gov/pubmed/7573055

Nowatzki, N. R. (2012). Wealth inequality and health: A political economy perspective.

International Journal of Health Services, *42*(3), 403–424. https://doi.org/10.2190/HS.42.3.c

OECD. (2023). *Income inequality (indicator)*. https://doi.org/doi: 10.1787/459aa7f1-en (

Osborne, D., Sibley, C. G., & Sengupta, N. K. (2015). Income and neighbourhood-level

inequality predict self-esteem and ethnic identity centrality through individual-and group-based relative deprivation: A multilevel path analysis. *European Journal of Social Psychology*, *45*(3), 368–377.

Pabayo, R., Dunn, E., Gilman, S., Kawachi, I., & Molnar, B. (2016). Income inequality within urban settings and depressive symptoms among adolescents. *J Epidemiol Community Health*, *70*(10), 997–1003.

Pabayo, R., Kawachi, I., & Gilman, S. (2014). Income inequality among American states and the incidence of major depression. *J Epidemiol Community Health*, *68*(2), 110–115.

Paczkowski, M. M., & Galea, S. (2010). Sociodemographic characteristics of the neighborhood and depressive symptoms. *Current Opinion in Psychiatry*, *23*(4), 337–341.

Paglia, A., & Room, R. (1999). Preventing Substance Use Problems Among Youth: A Literature Review and Recommendations. *Journal of Primary Prevention*, *20*(1), 3–50. https://doi.org/10.1023/A:1021302302085

Papachristou, E., Flouri, E., Kokosi, T., & Francesconi, M. (2019). Main and interactive effects of inflammation and perceived neighbourhood cohesion on psychological distress: results from a population-based study in the UK. *Quality of Life Research*, *28*(8), 2147–2157.

Pascoe, M. C., Hetrick, S. E., & Parker, A. G. (2020). The impact of stress on students in secondary school and higher education. *International Journal of Adolescence and Youth*, *25*(1), 104–112. https://doi.org/10.1080/02673843.2019.1596823

Patel, V, Burns, J., Dhingra, M., Tarver, L., Kohrt, B., & Lund, C. (2018). Income inequality and depression: a systematic review and meta-analysis of the association and a scoping review of mechanisms. *World Psychiatry*, *17*(1), 76–89.

Patel, Vikra, Burns, J. K., Dhingra, M., Tarver, L., Kohrt, B. A., & Lund, C. (2018). Income

inequality and depression: A systematic review and meta-analysis of the associations and a

scoping review of mechanisms. *World Psychiatry*, *17*, 76–89.

Patte, K. A., Bredin, C., Henderson, J., Elton-Marshall, T., Faulkner, G., Sabiston, C., Ferro, M.,

Battista, K., & Leatherdale, S. T. (2017). *Development of a mental health module for the*

COMPASS system: improving youth mental health trajectories. Part 1: Draft Development

and Design. Compass Technical Report Series. University of Waterloo.

https://uwaterloo.ca/compass-system/development-mental-health-module-compass-system-

improving

Patten, S. B., Williams, J. V. A., Lavorato, D. H., Wang, J. L., McDonald, K., & Bulloch, A. G.

M. (2015). Descriptive epidemiology of major depressive disorder in Canada in 2012.

Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie, *60*(1), 23–30.

https://doi.org/10.1177/070674371506000106

Pattussi, M. P., Olinto, M. T. A., Rower, H. B., de Bairros, F. S., & Kawachi, I. (2016).

Individual and neighbourhood social capital and all-cause mortality in Brazilian adults: a

prospective multilevel study. *Public Health*, *134*, 3–11.

Pearce, N., & Davey Smith, G. (2003). Is social capital the key to inequalities in health?

American Journal of Public Health, *93*(1), 122–129. https://doi.org/10.2105/ajph.93.1.122

Pega, F., Liu, S. Y., Walter, S., & Lhachimi, S. K. (2015). Unconditional cash transfers for

assistance in humanitarian disasters: Effect on use of health services and health outcomes in

low-and middle-income countries. *Cochrane Database of Systematic Reviews*, *9*.

Pega, F., Pabayo, R., Benny, C., Lee, E.-Y., Lhachimi, S. K., & Liu, S. Y. (2022). Unconditional

cash transfers for reducing poverty and vulnerabilities: effect on use of health services and

health outcomes in low-and middle-income countries. *Cochrane Database of Systematic*

Reviews, *3*.

Perrin, B. (2020, March 12). Alberta's war against safe injection istes. *Macleans*.

Pickett, K. E., & Wilkinson, R. G. (2017). Immorality of inaction on inequality. In *BMJ* (Vol. 356). British Medical Journal Publishing Group.

Pijl, S. J., Frostad, P., & Mjaavatn, P.-E. (2011). Segregation in the classroom: What does it take to be accepted as a friend? *Social Psychology of Education*, *14*(1), 41–55.

Public Health Ontario. (2020). *Rapid review: Substance use-related harms and risk factors during periods of disruption*. https://www.publichealthontario.ca/- /media/documents/ncov/main/2020/08/substance-use-related-harms-disruption.pdf?la=en

Qian, W., Battista, K., Bredin, C., Brown, K. S., & Leatherdale, S. T. (2015). Assessing longitudinal data linkage results in the COMPASS study. *Compass Technical Report Series*, *3*(4). https://uwaterloo.ca/compass-system/publications/assessing-longitudinal-data-linkage- results-compass-study

Radez, J., Reardon, T., Creswell, C., Lawrence, P. J., Evdoka-Burton, G., & Waite, P. (2021). Why do children and adolescents (not) seek and access professional help for their mental health problems? A systematic review of quantitative and qualitative studies. *European Child & Adolescent Psychiatry*, *30*(2), 183–211. https://doi.org/10.1007/s00787-019-01469- 4

Research, C. I. for H. (n.d.). *CIHR's guidelines for health research involving Aboriginal people. 2007; CIHR, Ottawa*. http://www.cihr- irsc.gc.ca/e/documents/ethics_aboriginal_guidelines_e.pdf

Ribeiro, W. S., Bauer, A., Andrade, M. C. R., York-Smith, M., Pan, P. M., Pingani, L., Knapp, M., Coutinho, E. S. F., & Evans-Lacko, S. (2017). Income inequality and mental illness-

related morbidity and resilience: a systematic review and meta-analysis. *The Lancet Psychiatry*, *4*(7), 554–562.

Rich, C. L., Ricketts, J. E., Fowler, R. C., & Young, D. (1988). Some differences between men and women who commit suicide. *The American Journal of Psychiatry*.

Ridley, M. W., Rao, G., Schilbach, F., & Patel, V. H. (2020). *Poverty, Depression, and Anxiety: Causal Evidence and Mechanisms*. National Bureau of Economic Research.

Rivenbark, J. G., Copeland, W. E., Davisson, E. K., Gassman-Pines, A., Hoyle, R. H., Piontak, J. R., Russell, M. A., Skinner, A. T., & Odgers, C. L. (2019). Perceived social status and mental health among young adolescents: Evidence from Census data to cellphones. *Developmental Psychology*, *55*(3), 574.

Robinson, E., Sutin, A. R., Daly, M., & Jones, A. (2022). A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic in 2020. *Journal of Affective Disorders*, *296*, 567–576. https://doi.org/https://doi.org/10.1016/j.jad.2021.09.098

Rodgers, G. B. (1979). Income and inequality as determinants of mortality: an international cross-section analysis. *Population Studies*, *33*(3), 343–351. https://doi.org/10.1093/ije/31.3.533

Romano, I., Ferro, M. A., Patte, K. A., Diener, E., & Leatherdale, S. T. (2020). Measurement Invariance of the Flourishing Scale among a Large Sample of Canadian Adolescents. In *International Journal of Environmental Research and Public Health* (Vol. 17, Issue 21). https://doi.org/10.3390/ijerph17217800

Romano, I., Ferro, M. A., Patte, K. A., & Leatherdale, S. T. (2022). Measurement invariance of the GAD-7 and CESD-R-10 among adolescents in Canada. *Journal of Pediatric*

Psychology, *47*(5), 585–594.

Ruckert, A., Huynh, C., & Labonté, R. (2018). Reducing health inequities: is universal basic

income the way forward? *Journal of Public Health*, *40*(1), 3–7.

Saez, E. (2017). Income and wealth inequality: Evidence and policy implications. *Contemporary*

Economic Policy, *35*(1), 7–25. https://doi.org/https://doi.org/10.1111/coep.12210

Sareen, J., Afifi, T. O., McMillan, K. A., & Asmundson, G. J. G. (2011). Relationship between

household income and mental disorders. *Archives of General Psychiatry*, *68*(4), 419.

https://doi.org/10.1001/archgenpsychiatry.2011.15

Saunders, N. R., Kurdyak, P., Stukel, T. A., Strauss, R., Fu, L., Guan, J., Fiksenbaum, L., Cohen,

E., Guttmann, A., Vigod, S., Chiu, M., Hepburn, C. M., Moran, K., Gardner, W., Cappelli,

M., Sundar, P., & Toulany, A. (2022). Utilization of Physician-Based Mental Health Care

Services Among Children and Adolescents Before and During the COVID-19 Pandemic in

Ontario, Canada. *JAMA Pediatrics*, *176*(4), e216298–e216298.

https://doi.org/10.1001/jamapediatrics.2021.6298

Schäfer, A. (n.d.). *Review of "The Cash Ceiling."*

Scheffler, R., Petris, N., Borgonovi, F., Brown, T., Sassi, F., & Sirven, N. (2010). *Social Capital,*

Human Capital and Health: What is the Evidence ?

Scherma, M., Masia, P., Deidda, M., Fratta, W., Tanda, G., & Fadda, P. (2018). New

Perspectives on the Use of Cannabis in the Treatment of Psychiatric Disorders. *Medicines*

(Basel, Switzerland), *5*(4), 107. https://doi.org/10.3390/medicines5040107

Sherman, S. G., Cheng, Y., & Kral, A. H. (2007). Prevalence and correlates of opiate overdose

among young injection drug users in a large U.S. city. *Drug and Alcohol Dependence*,

88(2–3), 182–187. https://doi.org/10.1016/j.drugalcdep.2006.10.006

Skrove, M., Romundstad, P., & Indredavik, M. S. (2013). Resilience, lifestyle and symptoms of

    anxiety and depression in adolescence: the Young-HUNT study. *Social Psychiatry and*

    Psychiatric Epidemiology, *48*(3), 407–416.

Solar, O., & Irwin, A. (2010). *A conceptual framework for action on the social determinants of*

    health. WHO Document Production Services.

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for

    assessing generalized anxiety disorder: the GAD-7. *Archives of Internal Medicine*, *166*(10),

    1092–1097.

Standing, G. (2007). *How cash transfers boost work and economic security*.

Statistics Canada. (n.d.). *Table 1 Description of Canadian Census Health and Enviroment*

    Cohorts (CanCHECs). 82-003-X. Retrieved August 24, 2021, from

    https://www150.statcan.gc.ca/n1/pub/82-003-x/2019012/article/00003/tbl/tbl01-eng.htm

Statistics Canada. (2012). *Census division: Detailed definition*. Illustrated Glossary: 92-195-X.

    https://www150.statcan.gc.ca/n1/pub/92-195-x/2011001/geo/cd-dr/def-eng.htm

Statistics Canada. (2013). *Table 105-1101 Mental health profile, Canadian Community Health*

    Survey - Mental Health (CCHS), by age group and sex, Canada and provinces. CANSIM

    Tables.

Statistics Canada. (2020a). *Economic impacts and recovery related to the pandemic*.

    https://www150.statcan.gc.ca/n1/en/pub/11-631-x/2020004/s5-eng.htm

Statistics Canada. (2020b). *Table 11-10-0134-01 Gini coefficients of adjusted market, total and*

    after-tax income. Data.

StatsCAN Plus. (2022). *Youth mental health in the spotlight again, as pandemic drags on*.

    https://www.statcan.gc.ca/o1/en/plus/907-youth-mental-health-spotlight-again-pandemic-

drags

Stephenson, J. (2021). Children and Teens Struggling with Mental Health During COVID-19

Pandemic. *JAMA Health Forum*, *2*(6), e211701–e211701.

https://doi.org/10.1001/jamahealthforum.2021.1701

Subramanian, S. V, & Kawachi, I. (2003). Response: In defence of the income inequality

hypothesis. *International Journal of Epidemiology*, *32*(6), 1037–1040.

https://doi.org/10.1093/ije/dyg325

Sullivan, L. E., Fiellin, D. A., & O'Connor, P. G. (2005). The prevalence and impact of alcohol

problems in major depression: A systematic review. *The American Journal of Medicine*,

118(4), 330–341. https://doi.org/https://doi.org/10.1016/j.amjmed.2005.01.007

Šumonja, M. (2021). Neoliberalism is not dead – On political implications of Covid-19. In

Capital & Class (Vol. 45, Issue 2, pp. 215–227).

https://doi.org/10.1177/0309816820982381

Sun, P., Unger, J. B., Palmer, P., Ma, H., Xie, B., Sussman, S., & Johnson, C. A. (2012).

Relative income inequality and selected health outcomes in urban Chinese youth. *Social

Science & Medicine*, *74*(1), 84–91.

Thapar, A., Collishaw, S., Pine, D. S., & Thapar, A. K. (2012). Depression in adolescence.

Lancet (London, England), *379*(9820), 1056–1067. https://doi.org/10.1016/S0140-

6736(11)60871-4

The Daily: Statistics Canada. (2017). *Canadian Community Health Survey, 2015*.

Tiirikainen, K., Haravuori, H., Ranta, K., Kaltiala-Heino, R., & Marttunen, M. (2019).

Psychometric properties of the 7-item Generalized Anxiety Disorder Scale (GAD-7) in a

large representative sample of Finnish adolescents. *Psychiatry Research*, *272*, 30–35.

Tjepkema, M., Christidis, T., Bushnik, T., & Pinault, L. (2019). Cohort profile: The Canadian

    Census Health and Environment Cohorts (CanCHECs). *Health Reports*, *30*(12), 18–26.

Trout, D. L. (1980). The role of social isolation in suicide. *Suicide and Life-Threatening*

    Behavior, *10*(1), 10–23.

Vilagut, G., Forero, C. G., Barbaglia, G., & Alonso, J. (2016). Screening for Depression in the

    General Population with the Center for Epidemiologic Studies Depression (CES-D): A

    Systematic Review with Meta-Analysis. *PloS One*, *11*(5), e0155431–e0155431.

    https://doi.org/10.1371/journal.pone.0155431

Vilhjalmsdottir, A., Bernburg, J. G., Gardarsdottir, R. B., & Sigfusdottir, I. D. (2018).

    Community income inequality and adolescent emotional problems: A population-based

    study. *Journal of Community Psychology*, *46*(6), 715–733.

Vilhjalmsdottir, A., De Clercq, B., Gardarsdottir, R. B., Bernburg, J. G., & Sigfusdottir, I. D.

    (2019). Decreasing income inequality and adolescent emotional distress: a population-based

    case study of Icelandic adolescents 2006–2016. *International Journal of Public Health*,

    64(2), 253–263.

Vilhjalmsdottir, A., Gardarsdottir, R. B., Bernburg, J. G., & Sigfusdottir, I. D. (2016).

    Neighborhood income inequality, social capital and emotional distress among adolescents:

    A population-based study. *Journal of Adolescence*, *51*, 92–102.

Virtanen, M., Kivimäki, M., Joensuu, M., Virtanen, P., Elovainio, M., & Vahtera, J. (2005).

    Temporary employment and health: a review. *International Journal of Epidemiology*, *34*(3),

    610–622.

Volkow, N. D. (2004). The reality of comorbidity: Depression and drug abuse. In *Biological*

    Psychiatry (Vol. 56, Issue 10, pp. 714–717). Elsevier Science.

https://doi.org/10.1016/j.biopsych.2004.07.007

Walker, R., Kyomuhendo, G. B., Chase, E., Choudhry, S., Gubrium, E. K., Nicola, J. Y., Lødemel, I., Mathew, L., Mwiine, A., & Pellissery, S. (2013). Poverty in global perspective: is shame a common denominator? *Journal of Social Policy*, *42*, 215.

Walton, E. (2018). The meaning of community in diverse neighborhoods: Stratification of influence and mental health. *Health & Place*, *50*, 6–15.

Wardlaw, J. (2010). PRISMA Checklist. *Advice on How to Write a Systematic Review*, *2*, 1–12. https://doi.org/10.1371/journal.pmed1000097

Werner-Seidler, A., Perry, Y., Calear, A. L., Newby, J. M., & Christensen, H. (2017). School-based depression and anxiety prevention programs for young people: A systematic review and meta-analysis. *Clinical Psychology Review*, *51*, 30–47.

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., Charlson, F. J., Norman, R. E., Flaxman, A. D., & Johns, N. (2013). Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*, *382*(9904), 1575–1586.

Wiens, K., Bhattarai, A., Pedram, P., Dores, A., Williams, J., Bulloch, A., & Patten, S. (2020). A growing need for youth mental health services in Canada: examining trends in youth mental health from 2011 to 2018. *Epidemiology and Psychiatric Sciences*, *29*, e115–e115. https://doi.org/10.1017/S2045796020000281

Wilkins, N. J., Zhang, X., Mack, K. A., Clapperton, A. J., Macpherson, A., Sleet, D., Kresnow-Sedacca, M., Ballesteros, M. F., Newton, D., & Murdoch, J. (2019). Societal determinants of violent death: the extent to which social, economic, and structural characteristics explain differences in violence across Australia, Canada, and the United States. *SSM-Population*

Health, *8*, 100431.

Wilkinson, R., & Pickett, K. (2017). Inequality and mental illness. *The Lancet Psychiatry*, *4*(7), 512–513.

Wilkinson, R G. (1997). Socioeconomic determinants of health. Health inequalities: relative or absolute material standards? *BMJ*, *314*(7080), 591–595. https://doi.org/10.1136/bmj.314.7080.591

Wilkinson, Richard G. (1999). Health, hierarchy, and social anxiety. *Annals of the New York Academy of Sciences*, *896*, 48–63. https://doi.org/10.1111/j.1749-6632.1999.tb08104.x

Wilkinson, Richard G. (1992). Income distribution and life expectancy. *BMJ: British Medical Journal*, *304*(6820), 165.

Wilkinson, Richard G. (1997). Comment: income, inequality, and social cohesion. *American Journal of Public Health*, *87*(9), 1504–1506.

Wilkinson, Richard G, & Pickett, K. E. (2006). Income inequality and population health: a review and explanation of the evidence. *Social Science & Medicine*, *62*(7), 1768–1784.

Williams, A. J., Maguire, K., Morrissey, K., Taylor, T., & Wyatt, K. (2020). Social cohesion, mental wellbeing and health-related quality of life among a cohort of social housing residents in Cornwall: a cross sectional study. *BMC Public Health*, *20*(1), 985. https://doi.org/10.1186/s12889-020-09078-6

Wills, T. A., Sandy, J. M., Yaeger, A. M., Cleary, S. D., & Shinar, O. (2001). Coping dimensions, life stress, and adolescent substance use: a latent growth analysis. *J Abnorm Psychol*, *110*(2), 309–323. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation &list_uids=11358025

Wilson, S., Hicks, B. M., Foster, K. T., McGue, M., & Iacono, W. G. (2015). Age of onset and course of major depressive disorder: associations with psychosocial functioning outcomes in adulthood. *Psychological Medicine*, *45*(3), 505–514. https://doi.org/10.1017/S0033291714001640

Winkler, H. (2019). The effect of income inequality on political polarization: Evidence from European regions, 2002–2014. *Economics & Politics*, *31*(2), 137–162.

World Health Organization. (2015). *HIV and young people who inject drugs: a technical briefing*. World Health Organization.

World Health Organization (WHO). (2010). *A conceptual framework for action on the social determinants of health*.

World Health Organization Commission on the Social Determinants of Health. (2008). *Closing the gap in a generation: Health equity through action on the social determinants of health*. World Health Organization Social Determinants of Health.

Zhang, S., & Xiang, W. (2019). Income gradient in health-related quality of life—The role of social networking time. *International Journal for Equity in Health*, *18*(1), 1–10.

Zheng, H. (2012). Do people die from income inequality of a decade ago? *Social Science & Medicine (1982)*, *75*(1), 36–45. https://doi.org/10.1016/j.socscimed.2012.02.042

Zhu, Y., Matsuyama, Y., Ohashi, Y., & Setoguchi, S. (2015). When to conduct probabilistic linkage vs. deterministic linkage? A simulation study. *Journal of Biomedical Informatics*, *56*, 80–86.

Zoorob, M. J., & Salemi, J. L. (2017). Bowling alone, dying together: The role of social capital in mitigating the drug overdose epidemic in the United States. *Drug and Alcohol Dependence*, *173*, 1–9.

Appendix A Evidence of ethical approval

Figure A-1. Certification of completion of the Tri-Council Policy Statement: Ethical Conduct for Research involving humans Course on Research Ethics (TCPS 2: CORE).

Date of Issue:

Figure A-2. Notification of approval of Research Ethics Board (REB) application from the University of Alberta for the project described in Objectives 1, 2, and 3.

Notification of Approval

Date:	June 24, 2020
Study ID:	Pro00102121
Principal Investigator:	Roman Pabayo
Study Title:	Investigating the role of income inequality within schools on mental health among adolescents
Approval Expiry Date:	Wednesday, June 23, 2021
Sponsor/Funding Agency:	Women and Children's Health Research Institute WCHRI

RSO-Managed Funding:	Project ID	Title	Grant Status	Program	Project Start Date	Project End Date	Purpose	Other Information
	RES0050375							

Thank you for submitting the above study to the Research Ethics Board 2. Your application has been reviewed and approved on behalf of the committee.

Any proposed changes to the study must be submitted to the REB for approval prior to implementation. A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to access the staff, students, facilities or resources of local institutions for the purposes of the research.

Approval by the Research Ethics Board does not encompass authorization to recruit and/or interact with human participants at this time. Researchers still require operational approval (e.g. AHS) and must meet the requirements imposed by the public health emergency (Alberta COVID page).

Sincerely,

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).

Figure A-3. Notification of Ethics Clearance from the University of Waterloo for the COMPASS system, as described in Objectives 1, 2, and 3.

UNIVERSITY OF WATERLOO

OFFICE OF RESEARCH ETHICS

Notification of Ethics Clearance of Application to Conduct Research with Human Participants

Principal/Co-Investigator:	Dr. Scott Leatherdale	Department:	Cancer Care Ontario / Propel
Principal/Co-Investigator:	Dr. K Stephen Brown	Department:	Statistics and Actuarial Science
Principal/Co-Investigator:	Dr. Steve Manske	Department:	PROPEL
Principal/Co-Investigator:	Dr. Susan Elliott	Department:	Health Studies & Gerontology
Principal/Co-Investigator:	Dr. David Hammond	Department:	Health Studies & Gerontology
Principal/Co-Investigator:	Dr. Guy Faulkner	Department:	U of Toronto - Exercise Science
Principal/Co-Investigator:	Dr. Ruth Childs	Department:	U of Toronto - OISE
Collaborator:	Chad Bredin	Department:	Propel

ORE File #: 17264

Project Title: COMPASS Study: A cohort study evaluating how changes in school programs, policies, and resources impact health behaviours (2012-16)

This certificate provides confirmation that the additional information/revised materials requested for the above project have been reviewed and are considered acceptable in accordance with the University of Waterloo's Guidelines for Research with Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. Thus, the project now has received ethics clearance.

Note 1: This ethics clearance from the Office of Research Ethics (ORE) is valid for one year from the date shown on the certificate and is renewable annually, for four consecutive years. Renewal is through completion and ethics clearance of the Annual Progress Report for Continuing Research (ORE Form 105). A new ORE Form 101 application must be submitted for a project continuing beyond five years.

Note 2: This project must be conducted according to the application description and revised materials for which ethics clearance has been granted. All subsequent modifications to the project also must receive prior ethics clearance (i.e., Request for Ethics Clearance of a Modification, ORE Form 104) through the Office of Research Ethics and must not begin until notification has been received by the investigators.

Note 3: Researchers must submit a Progress Report on Continuing Human Research Projects (ORE Form 105) annually for all ongoing research projects or on the completion of the project. The Office of Research Ethics sends the ORE Form 105 for a project to the Principal Investigator or Faculty Supervisor for completion. If ethics clearance of an ongoing project is not renewed and consequently expires, the Office of Research Ethics may be obliged to notify Research Finance for their action in accordance with university and funding agency regulations.

Note 4: Any unanticipated event involving a participant that adversely affected the participant(s) must be reported immediately (i.e., within 1 business day of becoming aware of the event) to the ORE using ORE Form 106.

Susan Sykes
Susan E. Sykes, Ph.D., C.Psych.

12/23/2011
Date

http://iris.uwaterloo.ca/ethics/form101/ad/reports/certificateB1.asp?id=25203   12/23/2011

Figure A-4. **Notification of approval of Research Ethics Board (REB) application from the University of Alberta for the project described in Objective 4.**

Notification of Approval

Date:	April 20, 2021
Study ID:	Pro00109772
Principal Investigator:	Roman Pabayo
Study Title:	Understanding the Role of Social-Economic Inequality on Deaths Due to Drug Overdose, Suicide, and Alcoholic Liver Disease in Canada
Approval Expiry Date:	April 19, 2022
Sponsor/Funding Agency:	CIHR - Canadian Institutes for Health Research CIHR

RSO-Managed Funding:

Project ID	Title	Grant Status	Sponsor	Project Start Date	Project End Date	Purpose	Other Information
RES0052784	Understanding the Role of Social-Economic Inequality on Deaths Due to Drug Overdose, Suicide, and Alcoholic Liver Disease in Canada	Awarded	Project Scheme	2021-04-01	2022-03-31	Grant	

Thank you for submitting the above study to the Research Ethics Board 2. Your application has been reviewed and approved on behalf of the committee.

Approved Documents:

Protocol/Research Proposal
Grant proposal

Any proposed changes to the study must be submitted to the REB for approval prior to implementation. A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to recruit and/or interact with human participants at this time. Researchers still require operational approval as applicable (e.g. AHS, Covenant Health, ECSD etc.) and where in-person interactions are proposed, institutional and operational requirements outlined in the Resumption of Human Participant Research - June 24, 2020 must be met.

Sincerely,

Stanley Varnhagen, PhD.
Chair, Research Ethics Board 2

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

Appendix B: Supplemental Tables

Supplemental Table B-1. Reasons for exclusion of eligible studies for the review on income inequality and adolescent mental health.

Title	Authors	Published year	Reason for exclusion
Province-level income inequality and health outcomes in Canadian adolescents	Quon E.C.; McGrath J.J.	2015	Duplicate
La relation temporelle entre l'anxiete et la depression dans le contexte de la transition primaire-secondaire.	Richard, Roxanne; Marcotte, Diane	2013	Irrelevant exposure (e.g., absolute income)
Measuring Blue Space Visibility and 'Blue Recreation' in the Everyday Lives of Children in a Capital City.	Pearson, AL; Bottomley, R.; Chambers, Tim; Thornton, Lukar; Stanley, James; Smith, Moira; Barr, Michelle; Signal, Louise	2017	Irrelevant exposure (e.g., absolute income)
Decomposition of income-related inequality in upper secondary school completion in Sweden by mental health, family conditions and contextual characteristics	Vaezghasemi M.; Mosquera P.A.; Gustafsson P.E.; Nilsson K.; Strandh M.	2020	Irrelevant exposure (e.g., absolute income)
The relationship between perceived income inequality, adverse mental health and interpersonal difficulties in UK adolescents	Piera Pi-Sunyer, B; Andrews, J.L.; Orben, A.; Speyer, L.G.; Blakemore, S	2022	Irrelevant exposure (e.g., absolute income)
Sex differences in adolescent physical aggression: Evidence from sixty-three low-and middle-income countries	Nivette A.; Sutherland A.; Eisner M.; Murray J.	2019	Irrelevant outcome
Income Inequality or Performance Gap? A Multilevel Study of School Violence in 52 Countries.	Contreras, Dante; Elacqua, Gregory; Martinez, Matias; Miranda, Alvaro	2015	Irrelevant outcome
Trends and socioeconomic correlates of adolescent physical fighting in 30 countries	Pickett W.; Molcho M.; Elgar F.J.; Brooks F.; De Looze M.; Rathmann K.; Bogt T.F.M.T.; Gabhainn S.N.; Sigmundova D.; De Matos M.G.; Craig W.; Walsh S.D.; Harel-Fisch Y.; Currie C.	2013	Irrelevant outcome
The role of neighborhood income inequality in adolescent aggression and violence	Pabayo R.; Molnar B.E.; Kawachi I.	2014	Irrelevant outcome
Neighborhood Income Inequality and Adolescent Relationship Aggression: Results of a	Okeke N.; Rothman E.F.; Mumford E.A.	2020	Irrelevant outcome

Title	Authors	Published year	Reason for exclusion
Nationally Representative, Longitudinal Study			
National Child and Adolescent Health Policies as Indicators of Adolescent Mental Health: A Multilevel Analysis of 30 European Countries.	Hendriks, Anne M.; Bartels, Meike; Stevens, Gonneke W. J. M.; Walsh, Sophie D.; Torsheim, Torbjrn; Elgar, Frank J.; Finkenauer, Catrin	2020	Irrelevant outcome
School bullying, homicide and income inequality: a cross-national pooled time series analysis	Elgar F.J.; Pickett K.E.; Pickett W.; Craig W.; Molcho M.; Hurrelmann K.; Lenzi M.	2013	Irrelevant outcome
Structural determinants of youth bullying and fighting in 79 countries	Elgar F.J.; McKinnon B.; Walsh S.D.; Freeman J.; Donnelly P.D.; De Matos M.G.; Gariepy G.; Aleman-Diaz A.Y.; Pickett W.; Molcho M.; Currie C.	2015	Irrelevant outcome
Association of Early-Life Exposure to Income Inequality with Bullying in Adolescence in 40 Countries	Elgar F.J.; Gariepy G.; Dirks M.; Walsh S.D.; Molcho M.; Cosma A.; Malinowska-Cieslik M.; Donnelly P.D.; Craig W.	2019	Irrelevant outcome
The role of city income inequality, sex ratio and youth mortality rates in the effect of violent victimization on health-risk behaviors in Brazilian adolescents.	Ramos, Dandara de Oliveira; Daly, Martin; Seidl-de-Moura, Maria Lucia; Nadanovsky, Paulo	2017	Irrelevant outcome
Income Inequality and School Bullying: Multilevel Study of Adolescents in 37 Countries	Elgar F.J.; Craig W.; Boyce W.; Morgan A.; Vella-Zarb R.	2009	Irrelevant outcome
Suicide rates: Age-associated trends and their correlates	Shah, Ajit	2012	Irrelevant study population
Province-level income inequality and health outcomes in Canadian adolescents	Quon E.C.; McGrath J.J.	2014	Irrelevant study population
School, family, and subjective socioeconomic status: Relative status and adolescent health	Quon E.C.; McGrath J.J.	2014	Irrelevant study population
Neighbourhood disadvantage and depressive symptoms among adolescents followed into emerging adulthood	Goldstein R.B.; Lee A.K.; Haynie D.L.; Luk J.W.; Fairman B.J.; Liu D.; Jeffers J.S.; Simons-Morton B.G.; Gilman S.E.	2019	Irrelevant study population
Childhood family income and life outcomes in adulthood: Findings from a 30-year longitudinal study in New Zealand.	Gibb, Sheree J.; Fergusson, David M.; Horwood, L. John	2012	Irrelevant study population
Income inequality and the developing child: Is it all relative?	Odgers, Candice L.	2015	Wrong study design for the review (e.g.,

Title	Authors	Published year	Reason for exclusion
			commentary, editorial)
Homicide among young black men in Toronto: An unrecognized public health crisis?	Khenti A.A.	2013	Wrong study design for the review (e.g., commentary, editorial)
Early-Life Exposure to Income Inequality and Adolescent Bullying	Jarrett O.; Puusepp-Benazzouz H.; Poulton A.	2019	Wrong study design for the review (e.g., commentary, editorial)
Adolescent suicide in New York City: Plenty of room for new research	Ganz D.; Sher L.	2012	Wrong study design for the review (e.g., commentary, editorial)
42. Early-Life Income Inequality and Adolescent Mental Health and Bullying	Elgar F.J.; Gariepy G.	2020	Full text not available

Supplemental Table B-2. Reasons for exclusion of eligible studies for the review on income

inequality and Deaths of Despair.

Title	Authors	Published Year	Notes
Who dies from alcoholic liver disease and where are possible therapeutic interventions missed? An analysis of 755 deaths in a health community 2007-2010	Ryder S.; Coles T.; Bash K.; Allen T.	2011	Irrelevant exposure (e.g., absolute income)
Risk factors for suicide in depression in Finland: first-hospitalized patients followed up to 24 years	Aaltonen K.I.; Isometsa E.; Sund R.; Pirkola S.	2019	Irrelevant exposure (e.g., absolute income)
Social fragmentation, severe mental illness and suicide	Evans J.; Middleton N.; Gunnell D.	2004	Irrelevant exposure (e.g., absolute income)
Patterns of Suicide by Age and Gender in the Indian States: A Reflection of Human Development?	Steen, Della M.; Mayer, Peter	2003	Irrelevant exposure (e.g., absolute income)
Ecological association between suicide rates and indices of deprivation in the north west region of England: The importance of the size of the administrative unit	Rezaeian M.; Dunn G.; St. Leger S.; Appleby L.	2006	Irrelevant exposure (e.g., absolute income)
Drug-related deaths in Scotland 1979-2013: evidence of a vulnerable cohort of young men living in deprived areas	Parkinson J.; Minton J.; Lewsey J.; Bouttell J.; McCartney G.	2018	Irrelevant exposure (e.g., absolute income)
Unclassified drug overdose deaths in the opioid crisis: emerging patterns of inequity.	Boslett, Andrew J; Denham, Alina; Hill, Elaine L; Adams, Meredith C B	2019	Irrelevant exposure (e.g., absolute income)
Deprivation and suicide mortality across 424 neighborhoods in Seoul, South Korea: a Bayesian spatial analysis	Yoon T.-H.; Noh M.; Han J.; Jung-Choi K.; Khang Y.-H.	2015	Irrelevant exposure (e.g., absolute income)
Socio-economic inequalities in suicide attempts and suicide mortality in Quebec, Canada, 1990-2005	Burrows S.; Auger N.; Roy M.; Alix C.	2010	Irrelevant exposure (e.g., absolute income)
Influence of social and material individual and area deprivation on suicide mortality among 2.7 million Canadians: a prospective study	Burrows S.; Auger N.; Gamache P.; St-Laurent D.; Hamel D.	2011	Irrelevant exposure (e.g., absolute income)
Socioeconomic inequalities in suicide mortality in European urban	Borrell C.; Palencia L.; Mari Dell'Olmo M.; Morrisson J.; Deboosere P.; Gotsens	2019	Irrelevant exposure (e.g.,

Title	Authors	Published Year	Notes
areas before and during the economic recession	M.; Dzurova D.; Costa C.; Lustigova M.; Burstrom B.; Rodriguez-Sanz M.; Bosakova L.; Zengarini N.; Katsouyanni K.; Santana P.		absolute income)
The influence of the economic and social environment on deliberate self-harm and suicide: An ecological and person-based study	Hawton K.; Harriss L.; Hodder K.; Simkin S.; Gunnell D.	2001	Irrelevant exposure (e.g., absolute income)
County-level socioeconomic factors and residential racial, Hispanic, poverty, and unemployment segregation associated with drug overdose deaths in the United States, 2013-2017.	Frankenfeld, Cara L.; Leslie, Timothy F.	2019	Irrelevant exposure (e.g., absolute income)
Mapping suicide mortality in Ohio: A spatial epidemiological analysis of suicide clusters and area level correlates	Fontanella C.A.; Saman D.M.; Campo J.V.; Hiance-Steelesmith D.L.; Bridge J.A.; Sweeney H.A.; Root E.D.	2018	Irrelevant exposure (e.g., absolute income)
Relationship between financial crisis, suicide and social parameters in Greece	Papaslanis T.; Kontaxakis V.; Havaki-Kontaxaki B.; Papageorgiou C.	2015	Irrelevant exposure (e.g., absolute income)
Social and economic inequalities in fatal opioid and cocaine related overdoses in Luxembourg: A case-control study	Origer A.; Le Bihan E.; Baumann M.	2014	Irrelevant exposure (e.g., absolute income)
Socioeconomic and geographical disparities in prescription and illicit opioid-related overdose deaths in Orange County, California, from 2010‚Äì2014.	Marshall, John R.; Anderson, Craig L.; Lotfipour, Shahram; Chakravarthy, Bharath; Gassner, Stephen F.; Cooper, Richelle J.	2019	Irrelevant exposure (e.g., absolute income)
Is there any additional evidence for the epidemiological transition hypothesis of elderly suicides?	Shah, Ajit	2011	Irrelevant exposure (e.g., absolute income)
Elderly suicide rates: Cross-national comparisons and association with sex and elderly age-bands	Shah A.; Bhat R.; McKenzie S.; Koen C.	2007	Irrelevant exposure (e.g., absolute income)
Suicide in Portugal: Spatial determinants in a context of economic crisis	Santana P.; Costa C.; Cardoso G.; Loureiro A.; Ferrao J.	2015	Irrelevant exposure (e.g., absolute income)
Opioid-related overdose deaths by race and neighborhood economic hardship in chicago	Rushovich, Tamara; Arwady, M. Allison; Salisbury-Afshar, Elizabeth; Arunkumar, Ponni; Aks, Steven; Prachand, Nikhil	2020	Irrelevant exposure (e.g., absolute income)

Title	Authors	Published Year	Notes
The ecological association between suicide rates and indices of deprivation in English local authorities	Rezaeian M.; Dunn G.; St Leger S.; Appleby L.	2005	Irrelevant exposure (e.g., absolute income)
Suicide, deprivation, and unemployment: Record linkage study	Lewis G.; Sloggett A.	1998	Irrelevant exposure (e.g., absolute income)
The influence of deprivation on suicide mortality in urban and rural Queensland: an ecological analysis	Law C.; Snider A.-M.; De Leo D.	2014	Irrelevant exposure (e.g., absolute income)
Spatial Patterns and Neighborhood Characteristics of Overall Suicide Clusters in Florida from 2001 to 2010	Johnson A.M.; Woodside J.M.; Johnson A.; Pollack J.M.	2017	Irrelevant exposure (e.g., absolute income)
Is suicide mortality associated with neighbourhood social fragmentation and deprivation? A Dutch register-based case-control study using individualised neighbourhoods	Hagedoorn P.; Groenewegen P.P.; Roberts H.; Helbich M.	2020	Irrelevant exposure (e.g., absolute income)
Why are suicide rates rising in young men but falling in the elderly? -- a time-series analysis of trends in England and Wales 1950-1998.	Gunnell D; Middleton N; Whitley E; Dorling D; Frankel S	2003	Irrelevant exposure (e.g., absolute income)
Geographical patterns in drug-related mortality and suicide: Investigating commonalities in English small areas	Congdon P.	2019	Irrelevant exposure (e.g., absolute income)
Latent variable model for suicide risk in relation to social capital and socio-economic status	Congdon P.	2012	Irrelevant exposure (e.g., absolute income)
Spatial analysis of suicide mortality in Australia: Investigation of metropolitan-rural-remote differentials of suicide risk across states/territories	Cheung Y.T.D.; Spittal M.J.; Pirkis J.; Yip P.S.F.	2012	Irrelevant exposure (e.g., absolute income)
Alcohol-related mortality following self-harm: A multicentre cohort study	Bergen H.; Hawton K.; Webb R.; Cooper J.; Steeg S.; Haigh M.; Ness J.; Waters K.; Kapur N.	2014	Irrelevant exposure (e.g., absolute income)
Trends in mental health inequalities in England during a period of recession, austerity and welfare reform 2004 to 2013	Barr B.; Kinderman P.; Whitehead M.	2015	Irrelevant exposure (e.g., absolute income)

Title	Authors	Published Year	Notes
Socioeconomic inequalities in premature mortality in Colombia, 1998-2007: The double burden of non-communicable diseases and injuries	Arroyave I.; Burdorf A.; Cardona D.; Avendano M.	2014	Irrelevant exposure (e.g., absolute income)
Suicide mortality among youth in southern Brazil: A spatiotemporal evaluation of socioeconomic vulnerability	Alarcao A.C.J.; Dell' Agnolo C.M.; Vissoci J.R.; Carvalho E.C.A.; Staton C.A.; de Andrade L.; Fontes K.B.; Pelloso S.M.; Nievola J.C.; Carvalho M.D.	2020	Irrelevant exposure (e.g., absolute income)
Socioeconomic inequalities in health in the Tuscany Longitudinal Study (SLTO): persistence and changes over time in overall mortality and selected causes (lung cancer, liver cirrhosis, AIDS and overdose)	Merler E.; Benvenuti A.; Baldi P.; Nardulli M.C.; Olmastroni L.; Biggeri A.; Marchi M.; Dreassi E.	1999	Irrelevant exposure (e.g., absolute income)
It's not 'just deprivation': Why do equally deprived UK cities experience different health outcomes?	Walsh D.; Bendel N.; Jones R.; Hanlon P.	2010	Irrelevant exposure (e.g., absolute income)
To compare is to despair? A population-wide study of neighborhood composition and suicide in Stockholm	Liu, Ka-Yuet	2017	Irrelevant exposure (e.g., absolute income)
Trends in premature mortality in the USA by sex, race, and ethnicity from 1999 to 2014: an analysis of death certificate data	Shiels M.S.; Chernyavskiy P.; Anderson W.F.; Best A.F.; Haozous E.A.; Hartge P.; Rosenberg P.S.; Thomas D.; Freedman N.D.; de Gonzalez A.B.	2017	Irrelevant exposure (e.g., absolute income)
Trends in socio-economic inequalities in injury mortality among men in small areas of 26 Spanish cities, 1996-2007	Gotsens M.; Mari-Dell'Olmo M.; Perez K.; Palencia L.; Borrell C.; Other MEDEA Members	2013	Irrelevant exposure (e.g., absolute income)
Socio-economic inequalities in mortality due to injuries in small areas of ten cities in Spain (MEDEA Project)	Gotsens M.; Mari-Dell'Olmo M.; Martinez-Beneito M.A.; Perez K.; Pasarin M.I.; Daponte A.; Puigpinos-Riera R.; Rodriguez-Sanz M.; Audicana C.; Nolasco A.; Gandarillas A.; Serral G.; Dominguez-Berjon F.; Martos C.; Borrell C.	2011	Irrelevant exposure (e.g., absolute income)
Assessment of Racial/Ethnic and Income Disparities in the Prescription of Opioids and Other Controlled Medications in California.	Friedman, Joseph; Kim, David; Schneberk, Todd; Bourgois, Philippe; Shin, Michael; Celious, Aaron; Schriger, David L.	2019	Irrelevant exposure (e.g., absolute income)
Association between adolescent suicide and sociodemographic factors in Chile: Cross-sectional ecological study	Cuadrado, Crist√≥bal; Zitko, Pedro; Covarrubias, Trinidad; Hernandez, Dunia; Sade, Cristina; Klein, Carolina; Gomez, Alejandro	2015	Irrelevant exposure (e.g., absolute income)

Title	Authors	Published Year	Notes
Assessing the impact of socioeconomic variables on small area variations in suicide outcomes in England	Congdon P.	2013	Irrelevant exposure (e.g., absolute income)
Mortality by occupation-based social class in Italy from 2012 to 2014	Bertuccio, Paola; Alicandro, Gianfranco; Sebastiani, Gabriella; Zengarini, Nicolas; Costa, Giuseppe; La Vecchia, Carlo; Frova, Luisa	2018	Irrelevant exposure (e.g., absolute income)
Suicide rates: Age-associated trends and their correlates	Shah, Ajit	2012	Irrelevant exposure (e.g., absolute income)
Influence of early life factors on social inequalities in psychiatric outcomes among young adult Norwegian men	Kristensen P.; Gravseth H.M.; Bjerkedal T.	2010	Irrelevant exposure (e.g., absolute income)
Income-related inequalities in the prevalence of depression and suicidal behaviour: A 10-year trend following economic crisis	Hong J.; Knapp M.; Mcguire A.	2011	Irrelevant exposure (e.g., absolute income)
Weighing social and economic determinants related to inequalities in mortality	Pasarin M.I.; Borrell C.; Brugal M.T.; Diaz-Quijano E.	2004	Irrelevant exposure (e.g., absolute income)
Association entre desigualdad y tasa de suicidio en Colombia (1994-2013) = Association between inequality and suicide rate in Colombia (1994-2013)	Campo-Arias, Adalberto; Herazo, Edwin	2015	Reviewer could not read the manuscript due to the language
Inequalities in global health: A world-system analysis, 1945-present.	Collins, Anna L	2013	Irrelevant outcome
Causal inference approaches for understanding the social determinants of substance abuse and depression in the 21st century: The opioid epidemic and the great recession	Swift, Samuel L.	2019	Irrelevant outcome
Income inequality and mortality in metropolitan areas of the United States.	Lynch JW; Kaplan GA; Pamuk ER; Cohen RD; Heck KE; Balfour JL; Yen IH	1998	Irrelevant outcome
Social capital, income inequality, and firearm violent crime.	Kennedy BP; Kawachi I; Prothrow-Stith D; Lochner K; Gupta V	1998	Irrelevant outcome
Relative deprivation and suicide risk in South Korea	Pak T.-Y.; Choung Y.	2020	Irrelevant outcome
Deaths of Despair: Why? What to Do?	Scutchfield, F. Douglas; Keck, C. William	2017	Wrong study design for the review (e.g.,

Title	Authors	Published Year	Notes
			commentary, editorial)
Suicide risk among refugees compared with non-refugee migrants and the Swedish-born majority population	Hollander A.-C.; Pitman A.; Sjoqvist H.; Lewis G.; Magnusson C.; Kirkbride J.B.; Dalman C.	2019	Wrong study design for the review (e.g., commentary, editorial)
The problems of relative deprivation: Why some societies do better than others	Wilkinson R.G.; Pickett K.E.	2007	Wrong study design for the review (e.g., commentary, editorial)
Making sense of economic deprivation as a predictor of suicide and homicide: A nationwide register-study	Pompili M.; Vichi M.	2016	Wrong study design for the review (e.g., commentary, editorial)
Inequality of income and rates of violence in Caucasian and black groups	Lester, David	1996	Wrong study design for the review (e.g., commentary, editorial)
Opioid use, chronic pain and deprivation	Gulliford M.	2020	Wrong study design for the review (e.g., commentary, editorial)
Relation of income inequality to suicide and homicide rates	Lester, David	1987	Wrong study design for the review (e.g., commentary, editorial)
Socioeconomic Factors Associated With Liver-Related Mortality From 1985 to 2015 in 36 Developed Countries	Wenhao, Li, Kemos, P, Salciccioli, J.D., Marshall, D., Shalhoub, J., Alazawi, W	2021	No relevant analyses conducted

Supplementary Table B-3. Results from the unadjusted and adjusted models for the association between CD-level income inequality and z-transformed adolescent depression score by gender, COMPASS 2016/17-2018/19.

		Females						Males					
		Unadjusted model			Adjusted model			Unadjusted model			Adjusted model		
Variable		ß	95% CI	p-value	ß	95% CI	p-value	ß	95% CI	p-value	ß	95% CI	p-value
CD-level z-transformed Gini coefficient (zGini)		0.13	0.05, 0.22	0.001	0.10	0.01, 0.18	0.031	0.11	0.04, 0.19	0.002	0.08	0.01, 0.15	0.047
Year of study	2017/2018 (ref: 2016)	0.07	0.01, 0.12	0.022	0.01	-0.05, 0.07	0.761	0.12	0.07, 0.17	<0.001	0.10	0.04, 0.15	0.001
	2018/2019	0.22	0.17, 0.28	<0.001	0.11	0.04, 0.17	0.002	0.23	0.17, 0.28	<0.001	0.14	0.08, 0.19	<0.001
Time trend	2017-18*zGini	-0.04	-0.11, 0.03	0.281	-0.05	-0.13, 0.03	0.234	-0.04	-0.11, 0.02	0.183	-0.06	-0.13, 0.01	0.096
	2018-19*zGini	-0.06	-0.13, 0.01	0.065	-0.07	-0.15, 0.01	0.079	-0.04	-0.11, 0.02	0.179	-0.06	-0.13, 0.01	0.103
CD-level													
% of visible minority households					-0.02	-0.09, 0.05	0.663				-0.01	-0.07, 0.04	0.618
% of lone-parent households					0.05	0.01, 0.08	0.007				0.04	0.01, 0.07	0.004
% of recent immigrant households					-0.03	-0.10, 0.05	0.531				-0.01	-0.08, 0.05	0.684
Median household income					0.05	0.02, 0.08	0.003				0.05	0.03, 0.08	<0.001
Individual-level													
Race/ethnicity	Black (ref: non-white)				-0.03	-0.11, 0.06	0.461				0.04	-0.02, 0.10	0.202
	Asian				0.04	-0.01, 0.09	0.135				0.11	0.07, 0.16	<0.001
	Hispanic				0.08	0.005, 0.16	0.038				0.05	-0.02, 0.11	0.198
	Other				0.12	0.08, 0.17	<0.001				0.12	0.08, 0.16	<0.001

		Est	95% CI	p	Est	95% CI	p		Est	95% CI	p	Est	95% CI	p
Weekly spending money	$1 to $5 (ref: $0)				-0.01	-0.06, 0.04	0.676					-0.02	-0.07, 0.02	0.346
	$6 to $10				-0.03	-0.08, 0.01	0.162					-0.03	-0.07, 0.01	0.148
	$11 to $20				-0.08	-0.12, -0.04	<0.001					-0.05	-0.09, -0.02	0.002
	$21 to $40				-0.07	-0.11, -0.02	0.002					-0.09	-0.12, -0.05	<0.001
	$41 to $100				-0.06	-0.10, -0.02	0.004					-0.06	-0.10, -0.02	0.001
	More than $100				-0.02	-0.06, 0.02	0.448					-0.08	-0.11, -0.05	<0.001
Age	In years				0.06	0.05, 0.07	<0.001					0.07	0.06, 0.08	<0.001
Intercept		0.02	-0.05, 0.10	0.523	-0.79	-0.98, -0.60	<0.001		-0.44	-0.51, -0.37	<0.001	-1.45	-1.61, -1.29	<0.001

Supplementary Table B-4. Results from the unadjusted and adjusted models for the association between CD-level income inequality and z-transformed adolescent anxiety score by gender, COMPASS 2016/17-2018/19.

Variable		**Females**						**Males**					
		Unadjusted model			Adjusted model			Unadjusted model			Adjusted model		
		ß	95% CI	p-value	ß	95% CI	p-value	ß	95% CI	p-value	ß	95% CI	p-value
CD-level z-transformed Gini coefficient (zGini)		0.19	0.10, 0.27	<0.001	0.13	0.04, 0.22	0.006	0.04	-0.03, 0.11	0.254	-0.01	-0.09, 0.06	0.708
Year of study	2017/2018 (ref: 2016)	0.07	0.02, 0.12	0.009	0.00	-0.06, 0.06	0.930	0.06	0.01, 0.11	0.014	0.05	0.01, 0.11	0.067
	2018/2019	0.19	0.14, 0.24	<0.001	0.05	-0.01, 0.11	0.093	0.13	0.0, 0.18	<0.001	0.07	0.01, 0.13	0.017
Time trend	2017-18*zGini	-0.07	-0.14, -0.01	0.024	-0.09	-0.16, -0.02	0.017	0.02	-0.04, 0.08	0.600	0.01	-0.06, 0.08	0.792
	2018-19*zGini	-0.08	-0.15, -0.02	0.01	-0.09	-0.17, -0.02	0.011	0.01	-0.05, 0.07	0.691	0.01	-0.06, 0.07	0.844
CD-level													
% of visible minority households					-0.04	-0.14, 0.06	0.388				-0.02	-0.08, 0.04	0.530
% of lone-parent households					0.08	0.03, 0.13	0.001				0.05	0.03, 0.08	<0.001
% of recent immigrant households					0.00	-0.11, 0.11	0.987				0.01	-0.06, 0.08	0.724
Median household income					0.09	0.05, 0.14	<0.001				0.05	0.02, 0.08	<0.001
Individual-level													
Race/ethnicity	Black (ref: non-white)				-0.17	-0.24, -0.10	<0.001				-0.09	-0.15, -0.03	0.003
	Asian				-0.13	-0.18, -0.08	<0.001				0.05	0.01, 0.10	0.018
	Hispanic				0.03	-0.05, 0.10	0.481				-0.02	-0.08, 0.05	0.597
	Other				0.05	0.01, 0.09	0.012				0.09	0.06, 0.13	<0.001
Weekly spending money	$1 to $5 (ref: $0)				-0.01	-0.05, 0.04	0.829				0.03	-0.01, 0.08	0.125
	$6 to $10				-0.01	-0.06, 0.03	0.585				-0.03	-0.07, 0.01	0.135
	$11 to $20				-0.05	-0.09, -0.01	0.012				-0.04	-0.08, -0.01	0.011
	$21 to $40				-0.05	-0.09, -0.01	0.008				-0.06	-0.10, -0.03	0.001
	$41 to $100				-0.01	-0.05, 0.02	0.463				-0.03	-0.07, 0.004	0.084

	More than $100				0.03	0.01, 0.07	0.073		-0.02	-0.05, 0.01	0.208
Age	In years				0.07	0.06, 0.08	<0.001		0.06	0.05, 0.07	<0.001
Intercept		0.02	-0.05, 0.10	0.523	-0.84	-1.02, -0.66	<0.001		-1.27	-1.43, -1.11	<0.001

Supplemental Table B-5. Table of correlations between the model variables at the individual level, CanCHEC (2006-2019).

	1	2	3	4	5
1. Age	1.000				
2. Gender	0.000	1.000			
3. Visible minority status	-0.048***	-0.002*	1.000		
4. Immigrant status	0.122***	-0.003**	0.250***	1.000	
5. Income quintile	0.095***	0.003***	-0.206***	-0.090***	1.000

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Supplemental Table B-6. Table of correlations between the model variables at the Census Division level, CanCHEC (2006-2019).

	1	2	3	4
1. z-transformed Gini coefficient	1.000			
2. z-transformed percent lone-parent households	0.406*	1.000		
3. z-transformed percent educated (at least high school) households	-0.407*	0.200*	1.000	
4. z-transformed mean household income (after-tax)	0.143*	-0.264*	-0.504*	1.000

* = p-value < 0.001

Appendix C: Additional details about the COMPASS Study

Supplementary Document C-1. Details on the Center for Epidemiologic Studies Depression Scale Revised (CESD-R-10) as employed in COMPASS.

Center for Epidemiologic Studies Depression Scale Revised (CESD-R-10)

About: This scale is a self-report measure of depression.

Items: 10

Reliability:
Internal consistency for the CES-D-10 = (Cronbach's α=0.86)
Test-retest reliability for the CES-D-10 = (I CC=0.85).
Test-retest reliability for individual items = (ICC=0.11-0.73)
(Miller et al. 2008)

Validity:
Convergent validity = .91
Divergent validity = .89
Correlation of the CES-D-10 to SF-36 subscales varies depending on the subscale.
Physical Function (Pearson's r =0.37)
Mental Health (Pearson's r=0.71)
(Miller et al. 2008)

Scoring:

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	All of the time (5-7 days)
Questions 5 & 8	3	2	1	0
All other questions	0	1	2	3

The total score is calculated by finding the sum of 10 items. Do not score the form if more than 2 items are missing. Any score equal to or above 10 is considered depressed.

Supplementary Document C-2. Details on the Generalized Anxiety Disorder-7-item questionnaire as employed in COMPASS.

GAD-7 Anxiety

Over the last two weeks, how often have you been bothered by the following problems?	Not at all	Several days	More than half the days	Nearly every day
1. Feeling nervous, anxious, or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it is hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid, as if something awful might happen	0	1	2	3

Column totals _____ + _____ + _____ + _____ =

Total score _____

If you checked any problems, how difficult have they made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult
☐	☐	☐	☐

Source: Primary Care Evaluation of Mental Disorders Patient Health Questionnaire (PRIME-MD-PHQ). The PHQ was developed by Drs. Robert L. Spitzer, Janet B.W. Williams, Kurt Kroenke, and colleagues. For research information, contact Dr. Spitzer at ris8@columbia.edu. PRIME-MD® is a trademark of Pfizer Inc. Copyright© 1999 Pfizer Inc. All rights reserved. Reproduced with permission

At a cut-off of 10, GAD-7: sensitivity =0.89, specificity = 0.82 (Spitzer et al., 2006) for indicating cases of Generalized Anxiety Disorder.

Reference: Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. Archives of Internal Medicine, 166(10), 1092–1097.

Supplementary Document C-3. Details on the Flourishing scale as employed in COMPASS.

The Flourishing Scale

The Flourishing Scale is a brief 8-item summary measure of the respondent's self-perceived success in important areas such as relationships, self-esteem, purpose, and optimism. The scale provides a single psychological well-being score.

Diener, E., Wirtz, D., Tov, W., Kim-Prieto, C., Choi, D., Oishi, S., & Biswas-Diener, R. (2009). New measures of well-being: Flourishing and positive and negative feelings. *Social Indicators Research, 39,* 247-266.

Below are 8 statements with which you may agree or disagree. Using the 1–7 scale below, indicate your agreement with each item by indicating that response for each statement.

1. Strongly disagree
2. Disagree
3. Slightly disagree
4. Mixed or neither agree nor disagree
5. Slightly agree
6. Agree
7. Strongly agree

I lead a purposeful and meaningful life.
My social relationships are supportive and rewarding.
I am engaged and interested in my daily activities
I actively contribute to the happiness and well-being of others
I am competent and capable in the activities that are important to me
I am a good person and live a good life
I am optimistic about my future
People respect me

Scoring: Add the responses, varying from 1 to 7, for all eight items. The possible range of scores is from 8 (lowest possible) to 56 (highest PWB possible). A high score represents a person with many psychological resources and strengths.

Supplementary Table C-1. Table of distribution characteristics and follow-up for each year, COMPASS 2016-19.

Variables		2016-17		2017-18		2018-19	
		n	%	n	%	n	%
	n	21118		19062		11355	
% retained at follow-up			100.0		90.3		53.8
Gender	n Boys	10027	47.5	8974	47.1	5350	47.1
	n Girls	10952	51.9	10011	52.5	5940	52.3
Ethnicity	n White	16848	79.8	15214	79.8	9053	79.7
	n Non-white	4270	20.2	3848.0	20.2	2302	20.3
Age	mean	15.2		16.1		16.9	

Supplementary Table C-2. Table of distribution characteristics and follow-up for each year, COMPASS 2018-21.

Variables		2018-19		2019-20		2020-21	
		n	%	n	%	n	%
	n	29722		14697		12995	
% retained at follow-up			100.00		49.45		43.72
Gender	n Boys	13479	45.35	6473	44.04	5519	42.47
	n Girls	16077	54.09	7974	54.26	7153	55.04
Ethnicity	n White	24439	82.23	12030	81.85	10987	84.55
	n Non-white	5283	17.77	2667	18.15	2008	15.45
Age	mean	15.20		15.87		16.32	