Urban neighborhood environments and adult affective health outcomes in Canada

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DEDICATION

This document is dedicated to all Canadians burdened by depression and other mental health issues, and to the residents of Montreal—a great city in constant flux.

ABSTRACT

Background: The lack of policy-ready research into the modifiable pathways linking neighborhoods to mental health outcomes—specifically the effects of neighborhood change on mental health—prompted the writing of this manuscript-based thesis. **Objective:** The first manuscript aims to elucidate the causal pathways and mechanisms through which neighborhoods affect depression outcomes in adult populations. The second manuscript seeks to summarize the observed relationships between neighborhood change and adult residents' psychological well-being. The third manuscript tests the hypothesis that neighborhood change may be related to psychological outcomes in Canada. **Methods:** The two systematic reviews identified literature in scientific databases using reproducible selection criteria. The original research study examines 2745 urban, community-dwelling adult participants from Canada's National Population Health Survey (NPHS). Associations were analyzed using multivariate linear regressions, controlling for key demographic characteristics, and stratified by baseline deprivation exposure. **Results:** Neighborhood socioeconomic disadvantage, instability, disorder, and social capital are associated with depressive symptoms. The proposed modifiable pathways linking these neighborhood characteristics and depression include: 1) the level of neighborhood-based stress that is placed on individuals; 2) the formation and strength of protective and supportive social networks; 3) the level of resiliency to negative affectivity and stress; 4) the perceptions of the aesthetic and form of residential space; and 5) the sense of control and agency in place of residence. These pathways represent potential areas for future research and intervention. Additionally, neighborhood change was observed to have a significant effect on psychological well-being. This observation was validated in the Canadian context using NPHS data. We found that both an improvement of social settings and a worsening of material settings were associated with worsening distress scores at follow-up. **Conclusions:** Further research requires a more systematic use of longitudinal design and a diversity of physical and social environmental measures. Interventions aimed at improving affective resiliency need to be tested. Future research would benefit from continued investigation of neighborhood change, especially with regards to social and economic vulnerability.

ABRÉGÉ

Contexte: Le manque de recherche sur le rôle déterminant des quartiers urbains sur la santé mentale—surtout dans un contexte Canadien—a motivé notre étude des effets des environnements urbains sur la dépression et de la détresse au Canada. **Objectif:** Le premier manuscrit de cette mémoire s'agit d'une revue systématique de la littérature qui vise à élucider les mécanismes par lesquels les quartiers influencent la santé mentale des adultes. Le second manuscrit, une deuxième revue systématique, vise à résumer les effets de la transformation des quartiers urbains sur le bien-être psychologique des résidents. Le troisième manuscrit teste l'hypothèse que le changement socioéconomique des quartiers urbain a des effets sur la santé mentale. **Méthodes**: Les deux revues ont identifié des textes dans des bases scientifiques en utilisant des critères de sélection reproductibles. Le troisième manuscrit suit 2745 participants de l'Enquête nationale sur la santé de la population du Canada, tous résidents de métropoles canadiennes. **Résultats:** Le désavantage socioéconomique, l'instabilité, le désordre, et les liens sociaux des quartiers sont tous associés avec les symptômes dépressifs. Nous avons identifié les mécanismes par lesquels ces caractéristiques urbains influencent la santé mentale: 1) l'environnement physique et social des quartiers peuvent être causes de stress; 2) les quartiers peuvent promouvoir ou empêcher la formation de réseaux sociaux qui promeut le soutient interpersonnel; 3) les quartiers peuvent influencer le niveau personnel de résistance conte l'affectivité négative et le stress; et 4) le sentiment de contrôle—que ce soit social ou même politique—au niveau du quartier peut affecter la santé mentale. De plus, le changement au niveau du quartier peut aussi avoir un effet sur le bien-être psychologique. Nous avons observé qu'une amélioration de l'environnement social, ainsi qu'une dégénération des conditions économiques, ont tous les deux donné lieu à une augmentation des symptômes de détresse. **Conclusion:** La santé mentale est influencée par l'environnement de quartier. Pourtant, il reste des suivis à faire. L'utilisation de données longitudinales et l'analyse d'interventions communautaires seront indispensables pour déterminer les meilleures démarches à suivre pour promouvoir la santé mentale des résidents urbains. Il reste aussi à étudier le changement au niveau des quartiers à l'égard de la vulnérabilité sociale et économique.

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PREFACE & CONTRIBUTION OF AUTHORS

As the first author of all three studies, I (**Alexandra Blair**) have made significant contributions regarding the formulation of hypotheses, research design, data analysis, and the drafting of these manuscripts. **Dr. Norbert Schmitz** provided substantial contributions regarding the research design, interpretation of findings, and manuscript revision for each of these manuscripts. He is a co-author in all three of the manuscripts. **Geneviève Gariepy** (PhD Candidate) has provided substantial contributions regarding the research design, interpretation of findings, and manuscript revision for each of these manuscripts. She is a co-author in all three of the manuscripts. **Dr. Nancy Ross** provided substantial contributions regarding the research design, interpretation of findings, and manuscript revision of the first manuscript. She is a co-author on the first manuscript. **Dr. Kaberi Dasgupta** provided feedback on the design of the third manuscript. **Bonnie Au** (MSc Candidate) acted as a secondary reviewer for the papers reviewed in the second manuscript of this thesis, and as a contributor regarding statistical analysis and result interpretation of the third manuscript.

INTRODUCTION

RATIONALE

What causes depression and distress? Depression is a clinically diagnosable affective disorder [1][1] known to be one of the leading causes of disease burden worldwide [2]. Psychological distress, on the other hand, is a more broad experience of affective symptoms such as sadness, anxiety, hopelessness, and restlessness [3]. The social and economic costs of affective health issues such as these are staggering [4]. Knowing what causes disorders such as depression or symptoms of distress is necessary for designing effective prevention strategies, promoting mental health, and reducing economic and healthcare costs to society.

Current prevalence of affective disorders suggests that strategies to prevent and alleviate psychological disease burden are needed. In Canada, an estimated 5% of adults will experience a major depressive episode this year alone, and approximately a quarter of the population will experience a major depressive episode during their lifetime [5]. Not only is depression known to reduce the quality of life of affected individuals, their families, and communities, it is also associated with functional disability, somatic diseases such as cardiovascular, metabolic and lung diseases, as well as early mortality [6-9]. It is estimated that the past-year prevalence of psychological distress in Canada is 21%, and that younger adults (15-24 years), women, people who are separated from their spouses or partners, as well as people with less education and lower socioeconomic status are disproportionately affected by distress burden [10]. These demographic, social, and economic disparities suggest that the etiology of

[1] Depression diagnosis: using the Diagnostic Statistical Manual (DSM-IV), an individual is diagnosed as having Major Depressive Disorder (MDD) if they exhibit at least one of the two core symptoms of depression (depressed mood and/or loss of interest in daily activities nearly every day for a consecutive period of two weeks). Additionally, in order to meet criteria for MDD individuals need to meet criteria for a total of 5 symptoms of depression, including: 1) Significant weight loss when not dieting or weight gain; 2) Insomnia or hypersomnia nearly every day; 3) Psychomotor agitation or retardation nearly every day; 4) Fatigue or loss of energy nearly every day; 5) Feelings of worthlessness or excessive or inappropriate guilt; 6) Diminished ability to think or concentrate, or indecisiveness, nearly every day; 7) Recurrent thoughts of death, recurrent suicidal ideation without a specific plan, or a suicide attempt or specific plan for committing suicide. Minor depressive disorder is experienced when an individual exhibits the two core symptoms listed above every day for at least two weeks. (American Psychiatric Association, 2000)

affective symptoms exists both within individual-based pathways as well as more distal pathways—such as those at societal and environmental levels.

Indeed, psychiatric epidemiologists—versed in interdisciplinary thinking and fully-aware of the importance of temporal, spatial, and social contexts of disease burden—suggests looking in tandem to determinants of health that reside beyond the individual self [11]. Epidemiological theorists have called for a paradigm shift towards an eco-epidemiological research approach [11]. This approach would take into account both macro level health determinants beyond the individual and micro level determinants within. It would also acknowledge the temporal life-course dimensions surrounding illness experiences [11]. Recommendations were made to unpack certain "black-boxes" or unquestioned facts of the epidemiological research process [12]. This new epidemiological paradigm seeks to understand causal pathways linking exposures to outcomes—asking not simply whether an association exists, but instead how, for whom, and under what circumstances does a determinant affect a particular health outcome [12].

In the spirit of pursuing a research paradigm that recognizes individuals' interdependence with the environments and contexts in which they live [11], my research examines the associations between neighborhood environments and affective mental health outcomes. Neighborhoods consist of the most chronic, daily areas of exposure to both stressors and protective networks of support [13]. The literature surrounding neighborhood effects on mental health has been growing since the mid-1990s. It is a relatively young body of work, and one that has evolved in tune with new methods of statistical analysis, contemporary datasets, and interdisciplinary partnerships between the fields of psychiatry, urban planning, epidemiology, biostatistics, and public health. Certain facts in this field are established: researchers have shown that even after controlling for individual-level risk factors such as age, sex, and socioeconomic status, exposure to neighbourhood social capital and material and social deprivation is associated with depression outcomes [14]. Following the principles of the eco-epidemiological approach however, it is not sufficient to simply observe a relationship between an exposure and an outcome. Certain questions remain. Namely,

how do these neighborhood characteristics affect depression outcomes? It is within the context of this realist query that the rationale of this thesis was conceptualized.

Two main theories exist to explain the association between neighborhoods and mental health outcomes. Research posits that neighbourhood characteristics may act as either stressors [15] or may promote networks of protective social support [14]. However, the causal mechanisms driving the relationships between neighbourhood factors and affective health have yet to be fully understood. For one, causal pathways have never been studied in a systematic fashion. This gap in the literature is problematic, since an exploration of potential modifiable pathways is necessary for the planning of relevant public health or clinical intervention. This thesis aims to fill this gap.

Furthermore, an additional gap in neighborhood-level literature pertains to the measurement of neighborhoods. Existing literature has been challenged with the task of conceptualizing neighborhoods as areas of exposure. For years, a research development focus has been placed on the spatial measure of neighborhoods. Researchers asked “what is a neighborhood?” Is it the 1-block radius around a participant’s home? Is it the 1000-meter walkable area around their residence? Can we use urban census tracts as reliable proxies for neighborhoods? Since the mid-1990s, debate over these questions dominated neighborhood-level literature. In a Canadian context, this conundrum of spatial definition was addressed in a conclusive study on Canadian neighborhood units, where census tracts were indeed proven to be reliable proxies for neighborhoods of residence [16]. This discovery facilitates the task for future research, as census tracts are far more accessible to study than neighborhood areas delineated using Geographic Information Systems (GIS). It also allows research to move on to other methodological challenges facing neighborhood measurement. Indeed, just as neighborhoods can be measured at varying spatial scales, temporality is also an important aspect to consider. Neighborhoods change through time, and currently, very little research has accounted for this reality.

Current research has not examined the health effects of social, economic, or political changes occurring both systematically and through planned interventions at a neighborhood level. When this thesis was written, very little was known about how these changes might affect the mental health of residents within urban, community settings.

No systematic review on the topic existed, and the relationship had not been tested in the Canadian context using quantitative data. This thesis addresses these additional gaps in the literature.

Thus, it is within the contexts of these three gaps in the literature—1) the lack of policy-ready research into the modifiable pathways linking neighborhoods to mental health outcomes, 2) the absence of a systematic summary of the relationship between neighborhood change and mental health, and 3) the paucity of quantitative evidence regarding the relationship between neighborhood change and mental health outcomes in Canada—that this thesis is written.

THESIS OBJECTIVES

The over-arching goal for this thesis is to unpack the relationship between urban neighborhood environments and mental health in Canada. This thesis is made of up three manuscripts: two systematic reviews and one original research study—each of which seek to answer specific research questions about the associations between urban neighborhood environments and adult mental health outcomes.

The first manuscript, a systematic realist review, asks how neighborhoods affect depression outcomes. At the time this manuscript was written, no review had offered a systematic synthesis of causal processes and context-specific factors that determine how and why neighborhoods affect depression outcomes in adult populations. This information is essential for the design of future community-level interventions. The objective of this first manuscript is to elucidate the causal pathways and mechanisms through which neighborhoods affect depression outcomes in adult populations, and to identify gaps in neighborhood-level psychiatric epidemiological literature.

The second manuscript, also a systematic review, seeks to examine the relationship between neighborhood change and adult residents' psychological well-being. The research questions examined in this second manuscript were the following: 1) what kinds of neighborhood change are documented in the literature? 2) Are people psychologically affected by these changes? 3) If so, who is affected, 4) in what contexts, and 5) in what ways? Finally, 6) what are the implications for future neighborhood-level interventions and research?

To follow up on the last review, we tested the hypothesis that neighborhood change is related to psychological outcomes using Canadian data. The objectives of the third manuscript of this thesis are 1) to assess the psychological effects of change in neighborhood social and material deprivation by describing types of change experienced by urban-dwelling adult Canadians, and 2) to compare the psychological distress outcomes of persons living in neighborhoods that have become better or worse, materially or socially, over time. This third manuscript accesses data from Canada's National Population Health Survey in combination with the Pampalon Social and Material Deprivation Index for Canadian Dissemination Areas.

1ST MANUSCRIPT: How do neighborhoods impact depression outcomes? A realist review and a call for the examination of causal pathways

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ABSTRACT

This systematic realist review seeks to elucidate the modifiable causal pathways through which neighborhoods affect depressive symptoms in adult populations. In this review, studies were identified using Medline, PubMed, PsycInfo, Geobase, and Web of Science databases, and chosen using reproducible selection criteria and systematic critical appraisal. A total of 14 longitudinal studies, published between 2003 and 2011, were included. Eleven of the articles observed a significant relationship between depression and at least one of the following neighborhood-level variables: neighborhood deprivation, disorder, instability, and social ties. Proposed modifiable pathways linking neighborhood characteristics and depression include: 1) the level of neighborhood-based stress that is placed on individuals; 2) the formation and strength of protective and supportive social networks; 3) the level of resiliency to negative affectivity and stress; 4) the perceptions of the aesthetic and form of residential space; and 5) the sense of control and agency in place of residence. These pathways represent potential areas for future research and intervention. Further research requires a more systematic use of longitudinal design and a diversity of physical and social environmental measures. Interventions aimed at improving affective resiliency need to be tested.

INTRODUCTION

Depression is a serious public-health problem and one of the leading causes of disease burden worldwide [2]. Not only is depression known to reduce the quality of life of individuals, their families, and communities, it is also associated with functional disability, cardiovascular, metabolic and lung diseases, as well as early mortality [6-9]. Individual risk factors for depression include childhood developmental factors, affective personality traits, as well as biological, cognitive, and psychosocial factors [18, 19]. On a population scale, a socioeconomic gradient in the health burden of depression exists [20], and has been attributed to environmental exposure [14, 21]. It is hypothesized that the social and material settings of one's neighborhood of residence—an area of chronic exposure to both socioeconomic stressors and protective social ties [21]—can affect depressive symptoms [14, 21]. Researchers have shown that even after controlling for individual-level risk factors, exposure to neighborhood social deficits or material deprivation is associated with depression outcomes [14]. The two existing theories explaining this relationship are that neighborhood characteristics can either act as stressors that trigger or worsen depressive symptoms [15] or that neighborhood environments mediate the social connections that are so necessary for ensuring resiliency against negative affectivity [14]. The causal mechanisms driving the relationships between neighborhood factors and depression have yet to be fully understood or summarized in a systematic review.

Four reviews have been published on the relationship between neighborhoods and depression [15, 22-24]. These reviews provide important summaries of current research, but lack a systematic synthesis of causal processes and context-specific factors that determine how and why neighborhoods affect depression outcomes. This information is essential in designing future community-level interventions targeted at improving community mental health outcomes. Indeed, in their seminal review, Diez Roux and Mair identify that "developing theory around the processes through which specific area features may affect mental health" is one of the most important research directions for this field of research [14]. A first step is to summarize the literature surrounding the proposed modifiable pathways linking neighborhood exposures to depression outcomes. The objective of this paper is to employ systematic review

methods, informed by a realist philosophy, to fill this gap in the literature, and elucidate the causal pathways and mechanisms through which neighborhoods may affect depression outcomes in adult populations.

METHODS

A realist review draws from but is different than a purely systematic literature review [26]. The realist approach shares the systematic review's use of reproducible and explicit methodologies to identify, appraise, and analyze relevant studies [27]. However, its underlying theoretical framework is different. A realist review is specifically designed to understand the contexts and causes of phenomena [26]; it recognizes that causal processes are contingent upon the contexts in which they occur [28], and intentionally seeks to understand how and why relationships exist rather than simply whether or not they occur—which has been the traditional or "black box" approach to conducting reviews [29]. A realist synthesis is useful for answering the questions of how certain exposures affect health outcomes, who they affect, and in what circumstances [26]. Though originally designed to assess health care and policy interventions, a realist approach can also be applied to synthesize observational studies [29]. Here, a realist approach will take the field of neighborhood-level research forward by explicitly identifying the pathways and conditions necessary for neighborhoods to affect depression outcomes and proposing the first summary of causal theory on the topic.

2.1 Search Strategy

Medline, PubMed, PsycInfo, Geobase, and Web of Science were the cross-disciplinary databases searched for published, peer-reviewed English language articles (Figure 1). An initial search was conducted using the terms "depression" or "depressive symptom*," and "neighborhood*" or "neighbourhood*," as found in the titles of publications. Of the 251 publications identified, 168 duplicate articles and 3 irrelevant publications were eliminated. Once the predetermined exclusion criteria were applied to the remaining 80 abstracts, 8 articles were identified. A snowball search based on the reference lists of these remaining articles and those of the four existing literature

reviews [15, 22-24] yielded 14 additional records, 6 of which met selection criteria and were included in the final review. Snowballing has been shown to identify a greater number of relevant sources than database or hand searching, and is a key component of the purposive sampling method of realist review [26]. The search was conducted between May 2012 and October 2013.

2.2 Inclusion and Exclusion Criteria

Most neighborhood-level research of health outcomes has been conducted in the past 15 years [14], and so the search was limited to works published since 1995. Publications selected were empirically-based longitudinal studies; cross-sectional studies, experimental studies, and literature reviews were excluded. The findings of previously published reviews, however, are incorporated into the discussion section in order to contextualize findings. Publications needed to include a clinically-validated outcome measure of depression or depressive symptoms, as well as a validated neighborhood-level exposure variable. Neighborhoods are defined geographical units that are smaller than, and exist within, a larger city or area unit (e.g. city blocks, census tracts, or enumeration areas). Community-based studies without adequate geographic coding or linking to place were excluded due to their lack of reproducibility. All articles discussed at least one causal pathway or mechanism linking neighborhoods to depression outcomes.

2.3 Data Extraction

Articles were critically appraised using Heller et al.'s checklist for public health research [30]. We applied Heller's et al.'s checklist to assess the quality of the studies' neighborhood and depression measures, as well as their focus on proposed causal mechanisms. Data from each paper were extracted and classified in a table format in Table 1 (Appendix A).

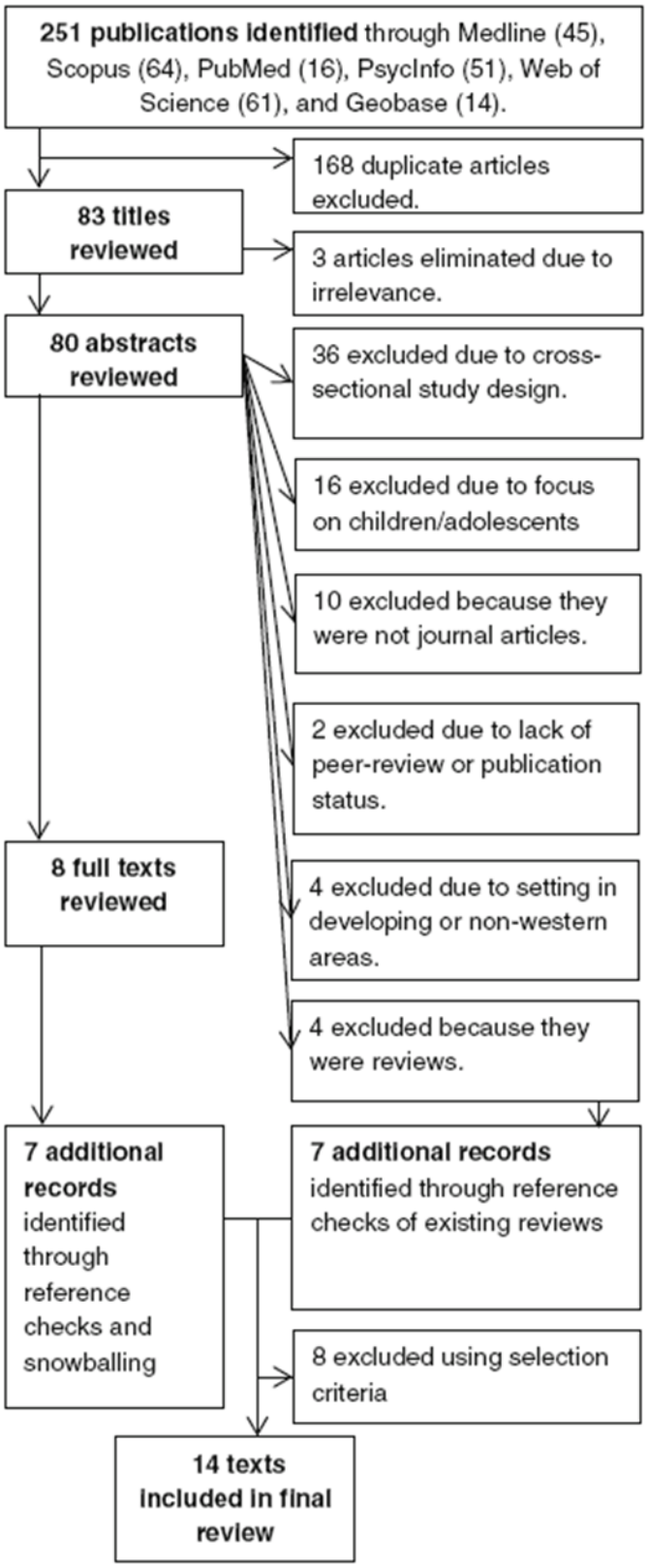

Figure 1: Article selection process

RESULTS

Fourteen articles were systematically reviewed. The publication dates of these papers ranged from 2003 to 2011. One study was set in Sweden [31], two were set in England [32, 33], and the other 12 were set in the United States—in both non-urban areas [34] and cities. The sample populations studied in these works varied greatly in size and characteristics. Sample sizes ranged from 136 individuals [35], to several hundreds or thousands, to 4.5 million [31]. All papers demonstrated satisfactory statistical power. Five publications were specifically limited to middle-aged or elderly populations [32, 36-39], and certain samples were limited to African American mothers [34], white mothers [40], or in the case of one study, limited to a population with high levels of substance abuse [41]. Despite the lack of generalizability, these studies offer insights into the effects of neighborhoods on specific sub-populations, which is valuable within a realist review framework [26]. Finally, all fourteen studies discussed risk of bias surrounding rates of follow-up. The interview follow-up rates were above 70% and satisfactory for ten of the reviewed articles. In the four studies that yielded lower rates, whiter, older, wealthier, urban-dwelling, and less depressed participants at baseline were more likely to respond at follow-up [36, 37, 40, 42]. Sample characteristics, and study settings and methods are described in further detail in Table 1.

3.1 Neighborhood contexts and measurements

A wide range of spatial units were used to study the neighborhood area, most of which were census-based neighborhood units that have been widely studied and validated in the literature [23, 43, 44]. Neighborhood-level variables included neighborhood disadvantage and deprivation, affluence, deterioration, safety, disorder and criminality, residential instability, socioeconomic status, social capital, social support, social cohesion, and racial and ethnic composition.

3.2 Depression measurement and control for confounding

Depression outcomes were assessed using several different diagnostic tests, all of which are clinically validated. However, depression assessment methods were highly heterogeneous in terms of timeframes of assessment (e.g. symptoms in past week, past

two weeks, or over lifetime) and diagnostic tools; some studies utilized symptoms scales, while others used clinical interviews or self-report data. Baseline and follow-up measurements of depressive symptomatology were taken in 13 of the fourteen studies; only one study examined depression solely at follow-up [45]. In studying the etiology of depression it is crucial to control for baseline symptoms, and ideally lifetime symptoms as well. This allows researchers to begin to address the issue of reverse causality or "social drift" wherein depressed people are thought to move to more deprived neighborhoods [10]. Other principle confounders were age, gender, education, income, employment, race, and marital status. Table 1 includes a summary of the confounding variables that models were adjusted for in each of the studies, and a visual summary of confounding variables and effect modifiers described in included studies is found in Figure 2.

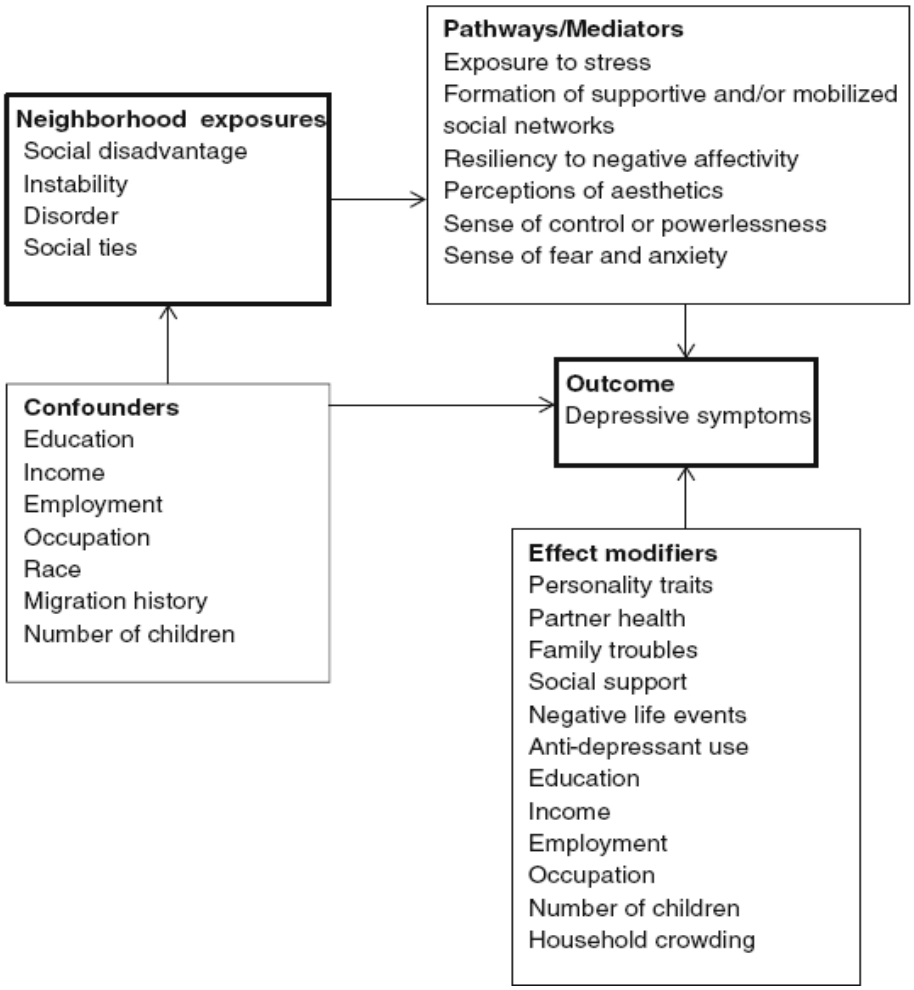

Figure 1: Summary of proposed pathways, confounding variables and effect modifiers in the relationship between neighborhood variables and depression outcomes in studies reviewed.

3.3 Neighborhood characteristics and proposed causal pathways

Three of the fourteen articles reported no significant prospective relationship between any neighborhood-level variables and depression outcomes [33, 38, 39]. The other eleven articles reported statistically significant relationships between at least one neighborhood-level variable and depression outcomes. Only two articles specifically tested the significance of causal pathways linking neighborhood characteristics to depression [42, 45], while the others made claims based on either existing literature or empirical observations of their data. This discrepancy in methodology will be discussed throughout the following sections, as the proposed linking pathways between depression and neighborhood-level measures are described and explained.

3.3.1 Socioeconomic disadvantage, deprivation, and deterioration

Neighborhood disadvantage, deprivation, and deterioration were measured in ten of the fourteen articles. These variables were derived from proxies such as rates of adult unemployment, household poverty, female-headed households, high school graduation, as well as income distribution and family composition. In two of the studies, the statistical significance of the relationship between neighborhood disadvantage and depression outcomes was lost after controlling for individual socio-demographic, economic, and health characteristics [33, 36]. In the remaining four studies, the relationship between neighborhood disadvantage, deprivation, and deterioration and depression outcomes was significant, even in unadjusted models [35, 38-40]. These four articles discuss three potential modifiable pathways through which neighborhoods affect depression outcomes. First, disadvantaged neighborhoods are likely the sites of exposure to multiple, negative, and concurrent stressors, which can interact to worsen depressive symptoms [46]. Second, neighborhood deprivation or affluence may affect individuals' resiliency or vulnerability to stressors and negative life events, which can put them at greater risk of experiencing depressive symptoms [34, 37]. Third, living in a deprived neighborhood makes individuals more likely to perceive disorder, and feel a sense of powerlessness therein [42]. Feeling powerless worsens depressive symptoms. Few studies have tested these pathways.

3.3.2 Instability and mobility

Instability, or the movement in and out of neighborhoods through time, was seen to affect depression outcomes in two of the studies reviewed [35, 40]. It was proposed that neighborhood instability can affect depression outcomes through three potential mechanisms. First, it can shape the amount of personal and community-level social, economic, and political investment into the neighborhood, which can have repercussions on the mental health of residents [35]. Secondly, it can affect the potential of social organization, which is needed to garner the political clout to advocate for health promoting services and resources [35, 40]. Finally, it can impact the support networks needed to protect individuals from worsening depressive symptoms [40].

3.3.3 Disorder, crime, and perceived safety

Neighborhood disorder, which was measured in six of the reviewed papers, was mostly derived from aggregate perceptions of youth delinquency, litter, public drinking and drug use, vandalism and graffiti, gang violence, and crime. The only objective measure of disorder was police-reported crime rates [45]. Though perception-based measures can create a problem of same-source bias, there is often a strong statistical correlation between perceived and objective markers of disorder [45]—making perceptions of crime, delinquency, and disorder strong proxies for actual measures. Two papers observed no statistically significant relationship between neighborhood disorder and depression outcomes in their respective populations of adults living in England [32] and older adults living in St-Louis Missouri [39], while four did observed a statistically significant relationship between these variables. In these four papers, two main pathways were proposed to explain the causal relationship between disorder and depression. First, neighborhood disorder affects the level of predictability and controllability in the neighborhood. A lack of predictability—in terms of environmental hazards, criminality, or social interactions—will lead residents to feel a lack of control, which can worsen depressive symptoms [34, 41]. Secondly, residents living in disorderly neighborhoods might feel an increased sense of fear, which can stop them from leaving their homes and forming protective social networks [45].

3.3.4 Social ties, cohesion, and social capital

Social capital is defined as the amount of investment, resources, and networks in any given locale that in turn produces relationships of trust, mutual aid, cohesion, and engagement [47]. Only two articles examined the relationship between social ties and networks and depression outcomes [31, 32]. Three ways through which neighborhood social ties affect depression outcomes were proposed. First, social participation can influence the formation of protective support networks, which in turn can improve depression symptomatology [31]. Secondly, social participation can allow people to feel more control and agency in affecting change to their living environments. A decrease in sense of powerlessness can have positive impacts on depression outcomes [31]. Finally, better social cohesion can imbue a greater sense of trust, which can positively impact the protective nature of friendships [32].

3.3.5 Ethnic composition

In three of the articles discussed above, a racial or ethnic composition variable was used to form an aggregate measure of neighborhood socioeconomic status or deprivation [31, 37, 39]. Indeed, race or neighborhood racial composition is often measured as a proxy for socioeconomic class; however its functionality as a pathway between neighborhood environments and depression outcomes is poorly understood. One article specifically observed the relationship between ethnic density and depression outcomes [36]. The authors observed a statistically significant protective effect for Hispanics living in high-density Hispanic neighborhoods. Though Wight et al. did not explain this observation, other authors have discussed the beneficial impacts of cultural proximity and ethnic solidarity [48, 49].

Table 2: Summary of proposed causal mechanism for each neighborhood-level variable

Neighborhood characteristic examined	Studies that found significant association between baseline neighborhood characteristic and depression outcomes, and the proposed mechanism	Studies that found no significant association
Social Disadvantage	*Cutrona et al. 2005*: Lack of economic opportunities and resources undermine sense of self- worth, affect resilience to stressors and life events. *Kim 2010*: Lack of protective social ties worsens depressive symptoms. *Galea et al. 2007*: Multiple stressors of living in a socially disadvantaged neighborhood seen to affect depressive symptoms. *Beard et al. 2009*: Affluence increases resiliency to negative affectivity.	*Wight et al. 2009* *Weich et al. 2005* *Buu et al. 2011* *Glymour et al. 2010* *Schootman et al. 2006*
Instability and mobility	*Buu et al. 2011*: Instability hinders the formation of protective social ties. *Santiago et al. 2011*: Mobility hinders community investment and social mobilization for the betterment of the community.	*Schootman et al. 2006*
Disorder, crime, perceived safety	*Cutrona et al. 2005*: Social disorder inhibits formation of supportive relationships, and decreases sense of predictability of place, which increases risk of depressive symptoms. *Curry et al. 2008*: Fear of crime limited between-people interactions and social capital development. *Latkin et al. 2003*: The lack of controllability associated with neighborhood disorder affects depressive symptoms. *Kim 2010*: Social disorder mediates relationship between neighborhood disadvantage and depression; social ties reduce but do not erase symptoms.	*Stafford et al. 2011* *Schootman et al. 2006*
Social ties, cohesion and social capital	*Lorfors and Sundquist 2006*: Poor social participation result in reduced social networks of support, and increased sense of powerlessness *Stafford et al. 2011*: Social cohesion influences sense of control in a neighborhood setting, which has impact on depressive symptoms.	

DISCUSSION

This realist review summarized the causal pathways linking neighborhoods to depression that are currently proposed in the literature. Eleven of the fourteen papers found a significant relationship between depression and at least one aspect of neighborhood exposure (Table 2). Neighborhood deprivation, disadvantage, disorder, crime and social ties significantly affected depression outcomes in the papers reviewed. Our review has shown that some of the proposed modifiable pathways linking the latter concepts to depression outcomes are the following: 1) the level of neighborhood-based stress that is placed on individuals; 2) the formation and strength of protective and supportive social networks; 3) the level of resiliency to negative affectivity and stress; 4) the perceptions of the aesthetic and form of residential space; and 5) the sense of control and agency in place of residence. The first three of these proposed pathways fit within the existing theories that neighborhoods act as stressors and affect protective social ties [14, 15]. These theories suggest that stress is a negative psychological reaction to a stressor, and in turn leads to activation of the biological stress response [50]—a response that is associated with worsening depressive symptoms [51]. Previous literature has described the effects of chronic exposure to everyday realities of pollution, noise, street lighting or lack thereof, crime, vandalism, or hate speech and discrimination [21, 52]. The chronicity and simultaneity of exposures to potential residential stressors is thought to mediate the relationship between neighborhood form and depressive symptoms [15].

Juxtaposed to this potential mediator of stress is the pathway of resiliency. Resiliency is defined as "a construct representing positive adaptation despite adversity"[53]. It is a marker of an individual's capacity to cope with stressors. In the context of neighborhoods, it is possible that if neighborhoods offer supportive services, recreational spaces, or any other opportunities for self-care, health promotion or the development of protective social support networks, negative affective symptoms can be alleviated [34, 37]. This proposed mechanism remains to be tested in future longitudinal research. The third proposed pathway complements the former two; supportive networks can aid in coping with stressors by promoting relationships of support and

care. Indeed, neighborhoods are the sites of chronic exposure to potentially protective social connections which can decrease feelings of social isolation, mediate coping behavior, and alleviate depressive symptoms [54].

Compared to the first three pathways noted, the last two proposed pathways mentioned above are extraneous to existing epidemiological theories about the relationships between neighborhoods and depression. Perceptions of aesthetics and sense of control are both associated with affectivity [55], but they are not discussed within existing stress or neighborhood social network theories [14, 15]. Perceptions of ecological stressors are directly informed by personality traits, mood, personal history, cultural norms, and demographics such as age, and coping skills [56], and they can mediate the stress pathway between stressors and stress response [50]. However, to date very little research has tested the relationship between perceptions of neighborhood-based stress and affectivity, or examined how perceptions of neighborhood environments can be modified to improve mental health outcomes. We recommend an examination of this proposed causal pathways in future research. Furthermore, though the themes of agency and control have been explored in other fields of epidemiological inquiry, such as workplace mental health research [57], they have rarely been studied in the context of neighborhoods of residence. Yet, these themes were evoked in several of the studies reviewed [34, 41]. The loss of sense of control accompanied by the witnessing of disorderly events or behaviors at a neighborhood-level can impact individuals' responses to stressors and impact their mental health outcomes [58]. The pathway of sense of control should also be examined in future research.

4.1 Strengths and limitations

The wide range of sample population sizes, research follow-up times, and heterogeneous tests for depression symptoms reduce comparability of studies to some degree. In terms of neighborhood-level exposures examined, there was a lack of studies examining the relationship between ethnic composition and depression outcomes. It is important to recognize that ethnic composition can have varying effects and meanings for different populations, depending on their demographic, socio-political,

cultural, economic, and historical contexts [59]. Future longitudinal, place-based research is needed to test the mechanisms linking race, ethnicity, and depression at a neighborhood level for both minority and non-minority communities. Furthermore, little research examined work area exposures, or neighborhood leisure-based exposures. Future research will benefit from an understanding of how different exposures combine to produce health outcomes.

Another limitation is the heterogeneity among studies in relation to the control of confounders. It could be particularly important for future research to systematically account for variables that are relevant to the specific outcome of depression, especially baseline depression symptoms [5, 18].

There was agreement among the articles on the significant associations between depression and neighborhood deprivation, social capital, instability, and disorder. These results are comparable to those found in other reviews on this topic [15, 22-24], which observed similar associations between facets of neighborhoods and depression outcomes in the literature they reviewed. However, none of these reviews specifically examined the causal pathways linking neighborhood attributes to depression outcomes in a systematic, reproducible manner. Many of them reviewed cross-sectional studies that could not make conclusions on the causal relationship between neighborhoods and depression outcomes. Among the articles studied, there was a strong amount of overlap between the proposed causal mechanisms; perceptions and experience of stress, support networks, resiliency, and positive affectivity were recurring themes in the discussions of articles reviewed. Several studies used these themes as springboards for recommending future areas of research and intervention. Proposed solutions include: investment in community organizations in order to strengthen neighborhood-level social ties; improvement of social service and resource provision within deprived neighborhoods in order to offer support to vulnerable individuals and families; and change of the aesthetic or physical quality of neighborhoods through community clean-ups, vandalism control strategies, and garbage collection. These strategies, and the pathways they aim to modify, remain to be fully tested—either through an examination of natural experiments or community-research partnerships in intervention design. Future research also requires a more systematic use of longitudinal design, relevant

control variables, and a diversity of neighborhood-level measures that account both for the physical and social environment.

4.2 Conclusions

Neighbourhoods can affect depression outcomes through environmental disorder, crime, social ties, and deprivation-related stressors. It is hypothesized that these aspects of neighbourhoods affect depression outcomes through individual perceptions, feelings, and emotions in both positive and negative ways. Future research is needed to explore these pathways further. Though several studies made brief suggestions for future neighbourhood-level interventions aimed at improving affective resiliency, these cursory recommendations indicate the lack of policy-readiness within the body of literature surveyed. It remains unclear, for example, how to improve social ties within a community. It will be important for future research to both develop a more thorough explanation of the ways in which interventions can be designed, and systematically test the mental health effects of these neighbourhood-level interventions.

Conflicts of Interest

The authors declare that there is no duality of interest associated with this manuscript.

BRIDGE: Connecting manuscripts 1 and 2

The first manuscript elucidates several key issues. Neighborhood disorder, crime, social ties, and deprivation were all shown to affect depressive symptoms through several potential pathways. However, each of these exposures was measured at one single point in time. The studies reviewed did not account for changes in any of the factors described, or the potential effects that these changes might have on affective outcomes. This gap in the literature is problematic insofar as it paints an inaccurate description of urban experience. Neighborhoods are in constant flux, and our scientific methods have not yet captured this

At the time this thesis was written, no systematic review had examined how social, economic, and political changes—occurring both systematically, and through planned interventions—might affect the mental health of residents within urban, community settings. We addressed this gap in the literature in the second manuscript of this thesis. The second manuscript is a systematic literature review of the effects of neighborhood change on mental health in adults. Accounting for time-varying exposures within psychiatric epidemiological research is a necessary step towards unpacking distal environmental determinants of health, and laying the groundwork quantitative analysis of longitudinal neighborhood data. The next manuscript consists of an important step forward in that direction.

2ND MANUSCRIPT: The effects of neighborhood change on psychological well-being: A systematic realist review

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Keywords: Mental Health; Well-being; Neighborhood; Urban Renewal; Realist Review; Systematic Review

ABSTRACT

This systematic literature review aims to summarize the relationship between neighborhood change and adult residents' psychological well-being. Studies were systematically identified using Medline and EmBase on Ovid, PubMed, PsycInfo on Scopus, Geobase, CINAHL, ASSIA, and Web of Science databases, and were chosen using reproducible selection criteria and critical appraisal. A total of 8 articles, both qualitative and quantitative in design, published between 1997 and 2012, were included in this review. Improvements to the neighborhood infrastructure and aesthetics, planned in partnership with local communities, were observed to have positive psychological effects on residents. The opposite was true in instances when the program was either too superficially planned, was not planned in partnership with community members, or did not include a mental health focus. The worsening of disadvantaged neighborhoods (i.e. through increase in disorder, gentrification) tended to result in negative affective outcomes among susceptible residents (i.e. older people, people with lower SES). No effect was observed among higher SES residents and those with strong social networks. These findings suggest that future longitudinal research is needed to assess the impact of neighborhood change, and to determine which aspects of neighborhoods can be modified in order to optimize mental health outcomes.

INTRODUCTION

Mental health issues pose a large burden of disease on affected populations [6-9]. Not only are health issues such as depression, anxiety, and distress known to reduce quality of life, they are also associated with functional disability, somatic diseases, as well as early mortality [6-9]. Psychological well-being, otherwise known as subjective well-being or positive well-being, can be conceptualized as a perception of both positive and negative affect [60]. In existing literature, well-being has been measured in a diversity of ways. Participants can been asked both one-item scales such as “Taking all things together, how happy are you?” [61], as well as multi-item scales such as the WHO-Five Well-being Scale [62]. A subjective well-being measurement encompasses a variety of affective symptoms, such as symptoms of depression, anxiety, and distress. It is therefore highly relevant to assess the general affective health of study populations.

Psychological well-being is dependent on a myriad of individual- and ecological-level factors. The focus of this particular review is the effect of neighborhood-level exposures on psychological well-being in adult populations. Neighborhoods are areas of chronic exposure to both socioeconomic stressors and protective social ties [21]. They can therefore impact affective symptomatology [14]. Previous reviews have demonstrated that a significant relationship exists between psychological well-being and neighborhood-level exposures such as social capital, socioeconomic deprivation, instability, and disorder [15, 22-24]. In existing literature, neighborhoods are mostly measured using highly-reproducible census-defined units such as census tracts and dissemination areas [23, 43, 44]. Alternatively, study participants have been asked to describe their neighborhood environment using a self-reported approach. In most studies however, neighborhoods characteristics are assessed in a cross-sectional fashion. Very little epidemiological neighborhood-level research has accounted for the transient, shifting nature of neighborhood environments, or how changes to neighborhoods through time may impact psychological well-being. We address this gap in the literature in this review.

The socioeconomic, cultural, and physical landscapes of neighborhoods can change through a variety of interventions. Urban renewal projects, gentrification processes, redevelopment and land-use changes are some of the ways through which

the geographies of neighborhoods can transform. To date, at least one research synthesis has summarized the effects of neighborhood regeneration programs designed between 1980 and 2004 on public health and health inequalities in the United Kingdom [63]. However, the latter is limited in scope; it only examines the effects of planned neighborhood programs, its focus is mostly physical health outcomes, and it does not include contexts outside of the UK. No systematic review has examined how forms of neighborhood change—both planned and unplanned—affects the mental health of adult residents across a more broad spectrum of countries and settings.

The objective of this paper is thus to conduct a systematic realist review of the relationship between the neighborhood change and adult residents' psychological well-being. The review will seek to answer the following questions: 1) what kinds of neighborhood change are documented in the literature? 2) Is psychological well-being affected by these changes? 3) If so, who is affected, 4) in what contexts, and 5) in what ways? Finally, 6) what are the implications for future neighborhood-level interventions and research?

METHODS

This review is identified as a systematic realist review because it is guided by a reproducible and systematic methodology to identify, appraise, and analyze relevant studies, and because it uses a realist synthesis approach to summarize the data [26, 27]. This study uses a realist data synthesis approach rather than a traditional approach for three reasons. First, realist data synthesis is differentiated from a traditional approach by its underlying theoretical framework; a realist philosophy recognizes that causal processes are contingent upon the contexts in which they occur [28], and seeks to understand how and why relationships exist rather than simply whether or not they occur [29]. Thus, this approach is relevant when studying the effects of neighborhood-level ecological exposure, because it allows us to unpack both the definition of neighborhoods as time-varying spatial concepts, and the causal relationship between neighborhoods and psychological well-being. Second, realist synthesis is structured to answer the questions of how certain exposures affect health outcomes, who they affect, and in what circumstances [26]. This is particularly relevant when studying the mental

health impacts of neighborhoods because the contexts of the latter are so diverse. One of the great challenges of pursuing neighborhood-level research is the heterogeneity of study samples, settings, and methodological approaches—as well the sheer paucity of studies. It would be inappropriate to conduct a systematic review that did not, at its core, adjust its approach to this reality. The realist approach was conceived as a tool to examine sparse, and highly heterogeneous literature and study designs [64].

2.1 Search Strategy

Medline and EmBase on Ovid, PubMed, PsycInfo on Scopus, Geobase, CINAHL, ASSIA, and Web of Science databases were searched for studies published before July 2013. Two search themes pertaining to the topics of mental health and changes to neighborhoods through time were combined using the Boolean operator “and”. Search themes, which include terms such as “depression,” “well-being,” “gentrif*,” and “neighb* regeneration,” are described in Table 1. Once studies were identified, selection criteria described below was applied. A snowball search based on the bibliographies of relevant studies was also conducted to yield further results. Snowballing has been shown to identify a greater number of relevant sources than database or hand searching [26].

Table 1: Terms searched in Titles, Abstracts, and Key Words of articles.

Topic	Search String
Psychological Well-being	depression OR depressed OR depressive OR "mood disorder*" OR “well-being” OR “well being” OR psychological OR affect* OR psychiatric OR stress OR distress OR anxiety OR anxious OR “quality of life” OR phobia OR “PTSD” OR trauma OR mental OR bipolar OR manic OR “rootshock” OR “root-shock”
Neighborhood Transformation	“resident* *stability” OR “neighb* *stability” OR gentrify OR gentrifi* OR “urban renewal” OR “neighb* renew*” OR “resident* renew*” OR displacement OR revitali* OR professionali* OR “residential mobility” OR “housing instabil*” OR “neighb* transformation*” OR “urban regeneration” OR “neighb* income change” OR “neighb* change” OR “de-housing” OR “residential transformation*” OR “urban regeneration” OR “neighb* regeneration”

2.2 Selection Criteria

Databases were searched for studies without regard for publication type. Works selected for the review were empirically-based observational or experimental studies. No distinction was made in relation to qualitative or quantitative study design. Literature reviews were excluded from the realist synthesis, but incorporated into the discussion section in order to contextualize findings. All publications were required to discuss at least one mental health outcome and one exposure to a change in neighborhood social, economic, political, or physical geography. Here, neighborhoods are defined as geographical units that are smaller than, and exist within, a larger city or area unit. Studies examining household-level change (e.g. housing rehabilitation interventions) without measure of changes at the broader neighborhood- or area-level were excluded. This review examined articles with adult sample populations (age 18 and above) based in developed countries of predominantly western culture. The purpose of restricting the scope of the review to this age range and these geographical settings was to decrease the heterogeneity of the sample, and maximize the comparability between study findings.

2.3 Critical Appraisal

To improve the consistency of the critical appraisal given the diversity of methods used by studies reviewed, the Critical Appraisal Skills Programme (CASP) critical appraisal checklists, which are recommended by the Cochrane Qualitative and Implementation Methods Group [65], were used. A critical appraisal of observational cohort studies was conducted using the CASP Cohort Study checklist [66]; the qualitative studies were assessed using the CASP Qualitative Research checklist [67]; the randomized controlled trial was assessed using the CASP Randomized Controlled Trial checklist, and finally, the quasi-experimental study was assessed using the Quality Checklist for Quasi-experimental Designs, which is a modified version of the Cochrane Effective Practice and Organized Care checklist [68]. The results of these critical appraisals can be found as additional materials (Appendix B: Table 2).

2.4 Data Extraction and Synthesis

Data from each paper were extracted and classified in a table format. Two separate tables were constructed to account for qualitative and quantitative research findings. Items referring to study design, methodology, and results were classified in Tables 3 and 4 (Appendix B).

RESULTS

Of the 2309 publications identified, 1436 irrelevant articles and 422 duplicate articles were eliminated. Selection criteria discussed below were applied to the abstracts of the 451 remaining articles by two independent reviewers. 426 articles were eliminated using selection criteria. After careful reading of the 25 remaining articles, another 19 were excluded. A snowball search based on the bibliographies of the remaining 6 articles was conducted [26]. Fourteen additional records were identified through snowball searches—12 of which did not meet selection criteria, resulting in a final number of 8 articles (Figure 1). Of the 8 articles reviewed here, three are interview-based qualitative studies [69-71], and five are quantitative studies: one observational cohort study with a 10-year follow-up period [72], one randomized control trial with 4,8,12, and 18 month follow-up periods [73], and three quasi-experimental studies—one with a five year follow-up period [74], another with a 22-month follow-up period [75], and a third with a three year follow-up period [76]. The details of these studies are described in Tables 3 and 4, and are discussed below.

3.1 Populations and settings

These studies are highly heterogeneous. Four of the studies are based in England [70, 71, 74, 75], the other four are based in Norway [72], Australia [76], Canada [69] and the United States [73] respectively. The size and demographics of the populations studied vary mainly in relation to the study type. The quantitative studies have sample sizes that range from 28 subjects [76] to 1344 [75], while the qualitative studies have samples sizes that range between 16 to 30 research participants. All studies examine adult populations, but Burns et al. [69] focus solely on elderly adults aged 68 years in older.

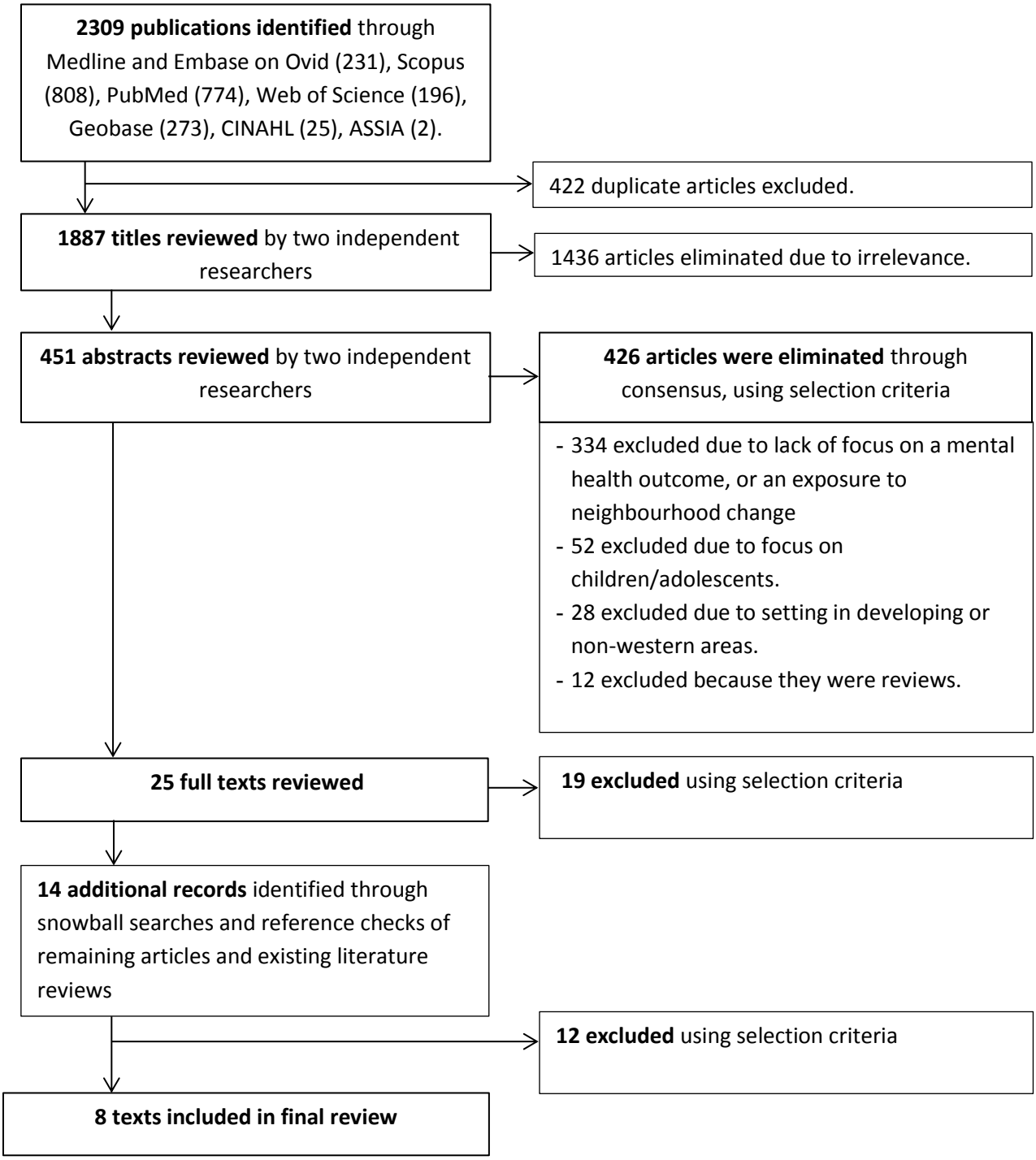

Figure 1: Flow chart of article selection for systematic review

3.2 Quality of studies

Based on the quality assessment checklists, most studies are of moderate to strong quality (Table 2). Weaknesses in the studies pertained mostly to the validity and reproducibility of the mental health measurement tools, the clarity of the study objectives, and the generalizability of the findings. Two quality concerns are especially relevant in this field of study: the control of confounding variables and the potential of reverse causation. To eliminate the possibility of reverse causation, wherein mental health history would influence people's choice of neighborhoods, a prospective study of samples that exhibit no mental health issues at baseline or over their past life course is needed. The latter design is not used in the studies examined. However, all five of the quantitative studies reviewed accounted for baseline symptoms, as well as several important demographic variables such as sex, age, and some indicator of socioeconomic status (e.g. education level or income).

3.3 What neighborhood changes are documented in the literature?

There are two major types of changes that were studied in the seven articles reviewed: changes that occurred due to explicitly designed urban regeneration programs, and spontaneous, unplanned changes that occurred due to economic and social processes. The urban regeneration programs described in five of the studies [70-72, 75, 77] affected infrastructure such as transport and street lighting [70-72, 75, 77], employment opportunities and services [70, 75], land-use designation [77], housing quality [70], and social community development [71, 72]. Only two studies documented processes of neighborhood social and economic change that occurred outside of official programs or policy initiatives [69, 73]. These changes include ethno-cultural diversification of mostly homogenous, white communities [69], gentrification processes that mark a socio-demographic transition in working-class neighborhoods towards younger professional, wealthier, and more educated residents [69], and fluctuation in neighborhood disorder [73].

3.4 Are residents psychologically affected by neighborhood changes?

The types of psychological affects assessed in the literature are highly heterogeneous. Studies assessed depressive symptoms [71-73], psychological well-being [70, 75], psychological distress [74, 76], and social exclusion and sense of attachment to place [69]. Some of these were measured using clinically-validated instruments, such as the 12-item General Health Questionnaire [70, 75], the Centre for Epidemiological Studies Depression Scales [71, 73], and the Kessler Psychological Distress Scale [76], while others were assessed using non-validated questionnaires. This lack of systematic reproducibility and clinical validation of some of the mental health measurement tools represents a significant gap in the epidemiological neighborhood-level literature, and makes it difficult to generalize about how residents are psychologically affected by changes occurring in their neighborhoods. The common thread between these measures is the theme of negative affectivity. Despite the heterogeneity of these measures, all of the studies reported an association between a change in affectivity of study participants and changes in their neighborhood environments. These associations are discussed below.

3.5 Who is affected by neighborhood change and how?

The observed effects of neighborhood change on adult psychological well-being are mixed, and often vary in relation to specific subpopulations within studies. Three studies report observing a positive effect of neighborhood change on residents, four studies observe a negative psychological effect of neighborhood change, and three discussed a lack of effect among specific sub-populations.

3.5.1 Positive Effects: Improvement of psychological well-being

Neighborhood change appeared to have a positive impact on psychological well-being in four contexts surveyed. First, a neighborhood improvement strategy aimed at improving the social environment of Oslo, Norway, was associated with an improvement of affective symptoms among older residents who did not move during the length of the study [72]. Second, improvements in transportation was associated with a decrease in the sense of entrapment and an improvement in reported quality of life of the study

participants living in a disadvantaged neighborhood in Manchester, England [70]. Third, an intervention aimed at improving the safety of residents, namely through street lighting and landscaping, was reported to have an important improvement in depressive symptoms among people living with mental illness in a disadvantaged neighborhood of London [71]. Fourth, an environmental and infrastructural renewal program in Northern England resulted in improvements in perceptions of safety and housing quality, and was accompanied by improved distress outcomes [74]. However, the latter initiative caused a reduction in population size as people left the area due to housing demolition. This outflow of residents was reported to be accompanied by a decline in community spirit.

3.5.2 Negative Effects: Worsening of psychological well-being

The impacts of neighborhood change were reversed in three other contexts and sub-groups, wherein study participants reported a worsening of mental health in relation to neighborhood change. First, the negative impacts of neighborhood change were observed among older adults, aged 68 to 95 years old, living in two neighborhoods of Montreal, Canada, that were experiencing the effects of gentrification and ethno-cultural diversification [69]. Changes in real-estate valuation and retail types resulted in people of lower socioeconomic status (SES) reporting a loss of agency over where they lived, and made it more difficult for older residents to socialize and leave their homes. These changes increase already-vulnerable residents' sense of social exclusion [69]. Moreover, the influx of non-white residents into the neighborhoods negatively affected certain white residents, due to their personal biases and the ideological influence of negative cultural stereotypes. The residents who embraced cultural diversification were not affected by this kind of change to their neighborhood. Secondly, a regeneration program aimed at improving infrastructure and services relating to transportation and employment was associated with a worsening of well-being among adults living in a disadvantaged neighborhood of South Manchester, England [70]. The disappointment with the superficiality of the regeneration program (i.e. purely cosmetic, without tackling root issues of insecurity, poverty, and discrimination) was associated with an increase in psychological distress. Finally, in the context of a randomized trial of female survivors of intimate partner violence living in the Midwest of the United States, the effects of a

change in neighborhood disorder was assessed. An increase in neighborhood disorder was associated with an decrease in reported quality of life [73].

3.5.3 No effect

In the context of an urban regeneration program in South Manchester, England, where changes were made to infrastructure and employment resources, no significant mental health improvement was observed among those living in the regenerated area, compared to the community that acted as a control [78]. It was noted that the intervention itself was not intentionally designed to improve psychological well-being. Secondly, a study conducted in Sydney, Australia, reported similar findings among participants who lived in a neighborhood that underwent renewal in the form of renovations to infrastructure and investment into community engagement activities [76]; though participants felt safer, no significant difference in distress scores was observed. Finally, in the Montreal study, residents with strong social networks were not affected by gentrification changes, as they felt confident in the supportive capacity of their friends and family [69].

3.6 What are the implications for future interventions and research?

The literature surveyed suggests several different paths for future neighborhood-level research and interventions. It was recommended that future research considers how gentrification affects social exclusion, and how neighborhoods affect aging in place [69]. Longitudinal research is needed, with longer follow-up periods to monitor the effects of neighborhoods through time [76]. Future randomized control trials or quasi-experimental trials require adequate control groups [71]. Finally, it was recommended that self-report data be combined with objective measurements of both exposure and outcome variables [73]. Future interventions could seek to promote and protect social spaces for older, lower-SES residents [69], improve the safety of residents by decreasing disorder [70, 73], as well as access to leisure opportunities [70]. The papers reviewed suggested that links of trust and partnership should be formed between community members and organizations leading regeneration initiatives in order to minimize the potential negative effects of interventions [70].

DISCUSSION

Neighborhood change can indeed affect adult residents' emotional affectivity. The literature surveyed included studies on planned and unplanned changes to neighborhoods. The studies examining unplanned changes to neighborhoods observed an association between neighborhood change and worsening psychological well-being. When neighborhood circumstances worsen (i.e. increase in disorder) or when unplanned changes make already susceptible residents (i.e. older people, people with lower SES) more vulnerable to socioeconomic risk factors (i.e. gentrification), sense of social exclusion and quality of life were affected [69, 73]. However, these negative, unplanned changes did not necessarily impact those residents of higher socioeconomic status or those with strong protective social networks. Of the planned changes, most regeneration interventions were observed to be associated with a positive mental health effect in the communities studied. Campaigns designed to improve transportation services or aesthetics, infrastructure, and design were associated with an improvement in sense of safety, sense of freedom and control, and improved quality of life—except in two instances, when the program was either too superficially planned, was not planned in partnership with community members, or did not include a mental health focus. Indeed, in other research urban renewal has been associated with negative health and social consequences, including "loss of affordable housing, interruption of social networks through relocation of residents, elimination of businesses, and reduced opportunities for fulfillment" [79] .

In summary, the surveyed literature suggests that neighborhood change can have both positive and negative psychological effects on residents. The literature suggests that if designed to improve the mental health of vulnerable residents and if planned holistically, intentionally, and in partnerships with local communities, re-investment in the form of regeneration programs can result in improved psychological well-being. However, if left the way they are, without re-investments for the benefit of more vulnerable residents, worsening in the social and physical geographies of disadvantaged neighborhoods tends to result in a worsening of reported affective outcomes. These observations correspond with the results of previous reviews. Thomson et al. observed a small positive impact on health of urban regeneration

campaigns in the UK, but warn that adverse health effects “remain a real possibility”[63]. The latter review also bemoaned the paucity of literature examining the impact of regeneration programs, as well as the lack of systematic post-intervention health assessments [63]. The scarcity of the literature in this area of study is but one of the many limitations restricting the observations of this review.

4.1 Strengths and limitations

The literature examining the effects of neighborhood change on psychological well-being is sparse and highly heterogeneous. A humble sample size of 8 studies is one of the most important limitations of this review. Moreover, the heterogeneity of the types of neighborhood-level change examined limits our ability to compare observations across community contexts. The diversity of study designs, follow-up times, population sizes, and demographic characteristics such as age range, racial profile, or ethno-linguistic identities make it difficult to generalize findings across various sample populations and suggest that this area of study is in dire need of greater research. These limitations are lessened only by the realist approach taken to synthesize the studies’ findings. Compared to traditional systematic or meta-analysis approaches, the realist approach is one of the better tools for tackling small, heterogeneous study samples. A further limitation is the possible lack of generalizability to non-Western or non-developed countries, and to non-adult populations. Furthermore, it is difficult to form generalized conclusions for specific disorders or symptoms due to the heterogeneity of the measures of psychological well-being assessed and the methods of assessment. These are the principle limitations of existing literature.

Despite these limitations, certain strengths bear mentioning. First, though some of the assessed outcome measures lack clinical relevance, the observed relationship between neighborhood change and psychological well-being—specifically in terms of negative affectivity—is relevant at a public health or population level and can give direction to future neighborhood-level research. Though neighborhood-level changes may not be able to cure anxiety, depression, or distress, this review suggests that they may be able to incrementally reduce the severity of symptoms on a population level. If

neighborhood change is able to effect the population distribution of affective symptoms [80], it is an extremely relevant area for public health research and intervention.

Moreover, this is the first systematic literature review to examine the relationship between changes at the neighborhood-level and psychological well-being. Despite the heterogeneity and small number of studies reviewed, this study fills a large gap in neighborhood-level literature, and marks and important step forward in understanding the myriad of ways neighborhoods impact mental health. The combination of qualitative and quantitative evidence is especially valuable to paint a complex portrait of the effects of both neighborhood regeneration programs and unplanned processes of gentrification.

4.2 Future directions and intervention recommendations

More rigorous neighborhood-level research is needed to understand the linkages between neighborhood spaces and psychological well-being. Measuring change is a difficult task, because it requires strong, innovative measurement tools, and a longitudinal dataset with both baseline and follow-up assessments. However, incorporating a more dynamic, time-varying understanding of neighborhoods is essential for unpacking the "black-box" surrounding neighborhood-level epidemiological research, and uncovering the modifiable causal pathways linking neighborhoods to psychological well-being [81]. Future directions for this area of research could include the pre- and post-intervention evaluation of regeneration programs, or the study of cohorts living in rapidly gentrifying neighborhoods. Authors have recommended that RCTs be conducted, but is methodologically- and ethically-questionnable whether neighborhood-based RCTs are feasible. Quasi-experimental approaches, such as natural experiments may be more realistic.

One key unanswered question in this field of research remains: how can the neighborhood environment be modified in order to improve the affectivity of adult residents? The literature surveyed in this review offer hints to elucidate the causal linkages between the exposure of neighborhood change and affective outcomes. Namely, holistic regeneration programs aimed at improving the health of current vulnerable residents by affecting several intersecting aspects of the neighborhood environment, such as the social (e.g. public meeting spaces and programs), political

(e.g. mobilization campaigns, community empowerment initiatives), economic (e.g. employment services, tenant services), and physical (e.g. parks, walkable streets) landscapes of urban living, seems to have the strongest association with changes towards positive affectivity. Future research would benefit from multi-level partnerships between clinicians, epidemiologists, and urban planners in studying the effects of large and small urban changes on psychological well-being.

CONCLUSION

Neighborhoods are areas of exposure to socio-ecological determinants of health. This is the first systematic review to examine the relationship between neighborhood change and psychological well-being in adults. The literature surveyed suggests that neighborhood change can indeed impact affectivity in both positive and negative ways. However, the literature is sparse and highly heterogeneous. Future rigorous, longitudinal research is needed to assess the impact of neighborhood change, and to determine which aspects of neighborhoods can be modified in order to optimize psychological well-being.

Conflicts of Interest

The authors declare that there is no duality of interest associated with this manuscript.

BRIDGE: Connecting manuscripts 2 and 3

Neighborhoods are shifting environments of ecological exposure to socio-ecological determinants of health. The second manuscript of this thesis was the first systematic review to summarize the observed relationship between neighborhood change and psychological well-being in adults. The review examined a heterogeneous sample of studies—some quantitative in design, others qualitative—and identified two main types of change: 1) change that was planned and occurred due to public health or urban planning intervention, and 2) unplanned change that occurred due to shifts in existing economic, social, or political systems. We found that both types of neighborhood change were indeed associated with adult residents' emotional affectivity.

This finding is alarming in the Canadian context due contemporary trends in neighborhood transformation. Unplanned changes occurring within neighborhoods—such as gentrification or ghettoization—have been occurring throughout Canadian metropolitan areas for years, and urban social and economic inequalities have become more apparent [82, 83]. It is possible that these unplanned, systematically-occurring changes may be affecting the mental health of Canadians, but this relationship has not yet been tested. Indeed, at the time this thesis was written, no quantitative study had examined the longitudinal psychological effects of unplanned social and economic changes on mental health in Canada. Thus, the objective of the third manuscript of this thesis was to fill this gap in neighborhood-level literature.

The third manuscript of this thesis is a longitudinal cohort study examining the effects of neighborhood material and social deprivation change on the psychological distress outcomes of urban-dwelling Canadian adults between the years 2000 and 2006. The study makes use of existing mental health data from Canada's nationally-representative National Population Health Survey, in combination with neighborhood-level census data on social and material deprivation from the Pampalon Deprivation Index for Canadian Dissemination Areas.

3RD MANUSCRIPT: The longitudinal effects of neighborhood social and material deprivation change on psychological distress in urban, community-dwelling Canadian adults

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ABSTRACT

This is the first Canadian study to assess how longitudinal changes in neighborhood material and social deprivation affect distress outcomes in urban-, community-dwelling adult Canadians. We paired data from 2745 urban participants of Canada's National Population Health Survey—who completed the Kessler 6-Item psychological distress screening tool at baseline and follow-up—with neighborhood social and material deprivation data from the census-based Pampalon Deprivation Index. Data were paired using participants' postal code. We conducted multiple linear regression models, which were stratified by baseline deprivation level and controlled for key confounders. We found that both an improvement of social settings and a worsening of material settings were associated with worsening distress scores at follow-up. These seemingly opposing findings are discussed in the context of existing literature on social renewal and neighborhood deterioration, and are made relevant for urban health research and policy. Future research would benefit from continued investigation of neighborhood change, especially with regards to social and economic vulnerability.

INTRODUCTION

Neighborhoods affect mental health outcomes. Several systematic literature reviews and longitudinal studies have observed an association between neighborhood-level measures and prospective mental health outcomes such as depressive and distress symptoms in adult, urban-dwelling populations [15, 22, 23, 25, 84]. However, neighborhoods have been measured as static entities, and very little work has been devoted to assessing the health effects of their transient, shifting nature. There is a significant gap in the literature surrounding the longitudinal assessment of the effects of neighborhood change, and the effects of these changes on mental health outcomes through time.

Several studies have examined the effects of neighborhood renewal and regeneration projects designed to improve the mental or physical health outcomes of residents, as well as the social and aesthetic qualities of living environments [15, 22, 23, 25, 84]. Results are mixed, but most of these studies suggest that an improvement of the social, material, and economic environments of neighborhoods are associated with bettered outcomes of psychological well-being. However, to our knowledge, few studies have quantitatively examined the longitudinal effects of unplanned, systematically-occurring material, social, and economic changes at the neighborhood level on mental health. The paucity of literature is especially alarming in the Canadian context, given contemporary trends in neighborhood transformation. In the past 20 years, researchers have noted that social and economic inequalities in Canadian cities are becoming more apparent [82]. It is therefore important to examine how changes in the socioeconomic contexts of neighborhoods impact the mental and physical health of Canadians.

It is our intention with this study to assess the psychological effects of changes in neighborhood social and material deprivation, by achieving the following goals: (1) describing types of neighborhood change experienced by urban-dwelling Canadians between 2001 and 2006, and (2) comparing the psychological distress outcomes of people living in neighborhoods that have become better or worse—materially and socially—over time.

METHOD

2.1 Sample

Data used in this study were drawn from the 4th and 7th waves (years 2000 and 2006, respectively) of the Canadian National Population Health Survey (NPHS), a longitudinal survey of a nationally-representative sample of Canadians (described here [85]). The sample of this study is restricted to urban[2][86] community-dwelling, non-institutionalized adult participants (aged 18 and above at baseline) from the NPHS who had not changed neighborhood of residence between 2000 (Time 1) and 2006 (Time 2) (n=2745).

We excluded rural respondents (n=2522) in order to improve the comparability of our findings to other studies conducted in urban settings, and to insure internal validity. Because Canadian Census units are defined using a population-density approach, neighborhoods have different meanings in cities than in rural area. Urban census tracts might cover a couple of city blocks, whereas rural census tracts—where residential density is lower—can span dozens of kilometers. It is thus a realist, context-aware approach [26] to exclude rural respondents. Furthermore, we chose to focus solely on non-movers in order to explicitly study the effects of neighborhood change as experienced by the long-term residents of these neighborhoods. We wanted to answer the question: how does it feel to live in a neighborhood that is changing? This

[2] Urban areas in Canada, or Census Metropolitan Areas (CMAs), are defined by Statistics Canada as areas that consist of one or more neighboring municipalities which have a total population of at least 100,000, of which 50,000 or more live in the core (2013).

distinguishes our study from studies of mobility that have measured the effect of moving in or out of neighborhoods with high or low deprivation. Compared to the non-movers, movers who were excluded from the sample (n=3198) tended to be younger, single, divorced, or widowed, be of non-Caucasian race, have not completed a post-secondary education, have lower levels of income adequacy, and report higher distress scores at baseline (Appendix C: Supplementary Table A). We also excluded respondents who were institutionalized (n=20), died (n=910), did not respond to the questionnaire at either time point (n=1376), or did not provide information on distress scores at follow-up (n=342). We restricted the time frame to the years 2000 and 2006 because information on neighborhood deprivation from census data was only available at those times [87].

2.2 Measures

2.2.1 Mental health measure: Psychological distress

Psychological distress is measured at baseline and follow-up. Psychological distress is measured using the Kessler 6-item Psychological Distress Scale, which encompasses an evaluation of both anxiety and depression symptoms [88]. Participants received scores ranging between 0 and 24, with the latter representing the highest level of psychological distress. Within the models of this study, distress scores are used as continuous measures, which has been done previously [89]. However, to account for highly skewed baseline and follow-up scores, both of the latter were log transformed (log*(score + 1), where 1 had to be added to the scores to allow for a score of zero to be included and relevant). We acknowledge that this transformation limits clinical interpretability. We chose to examine distress as a continuous measure to explore the full range of information from this variable. However, this approach relies on the assumption that the relationship between dependent and independent variables is linear. We included a measure of baseline distress in our study because past affective symptomatology is one of the most important predictors of future affective symptoms.

2.2.2 Neighborhood measures: Material and Social Deprivation

Neighborhood deprivation data at baseline and follow-up were obtained using the Pampalon Deprivation Index. The index is calculated for all Canadian dissemination

areas (smallest census unit), and is available online [87, 90]. Dissemination areas are uniform in terms of population size, and usually target between 400 and 700 residents [91]. The Pampalon Index, which has been used widely in Canadian studies [92, 93], is based on Canadian census data—making it therefore independent from our study sample. Based on factor analyses, the Pampalon Index consists of two dimensions: material and social deprivation. The material deprivation component is designed to capture ecological-level socioeconomic inequality. It is based on the proportion of persons without a high school diploma; the employment-population ratio; and the average personal income. The social component is designed to capture an ecological measure of social inequalities and vulnerabilities. The latter is based on the proportion of persons living alone; the proportion of individuals separated, divorced or widowed; and the proportion of single-parent families [87]. Pampalon et al.'s methodology is discussed elsewhere, and is widely accepted [87, 94]. These data were linked to NPHS data using respondents' postal codes.

In this study, change in neighborhood social and material deprivation was assessed by first creating binary exposure variable of relative low to medium deprivation (1^{st} to 3^{rd} quintiles) and relative high deprivation (4^{th} and 5^{th} quintiles). This codification has been done previously in the literature [87]. Four categories of neighborhood change were then created: 1) constant low-medium deprivation between baseline and follow-up, 2) constant high deprivation between baseline and follow-up, 3) low-medium baseline deprivation to high deprivation at follow-up (worsened), 4) high baseline deprivation to low-medium follow-up deprivation (improved). These classifications quantify the experience of living in a neighborhood that has transitioned from the lower quintiles of deprivation to the higher ones, and vice versa. These categories offer a very global measure of change, which was needed in a preliminary study such as this one.

2.2.3 Covariates

Based on our literature review, we included variables thought to confound the relationship between changes in neighborhood deprivation and psychological distress. Age (years), sex, race (Caucasian or non-Caucasian), marital status (married/in common law relationship or not married/in common law relationship), education (post-

secondary graduation, high-school graduation, or less than high school), past-year employment status (employed/non-employed), and income adequacy at baseline were obtained from the NPHS. Income adequacy (high/low) is an NPHS variable that is derived from the ratio of total household income and the number of people in the household [85].

2.3 Analysis

The association between distress scores and categories of neighborhood social and material deprivation change (change vs. no change) was assessed using multiple linear regression models. Models were stratified by baseline deprivation level (high or low/medium), in order to compare the effects of change between groups with similar baseline settings. That is, the distress scores of persons living in neighborhoods where worsening of deprivation level occurs—when low deprivation neighborhoods become more deprived—are compared to the scores of those living in stable low deprivation areas. In contrast, the distress scores of persons experiencing an improvement in deprivation—where high deprivation neighborhoods become less deprived—are compared to the distress scores of those living in high deprivation neighborhoods that remain stable. Model 1 examines the unadjusted relationship between neighborhood change and distress. Model 2 adjusts for sex, age, race, marital status, educational attainment, income adequacy, and employment status. In a third model (Model 3) we further adjusted for psychological distress at baseline to measure the association between changes in neighborhood deprivation and psychological distress at follow-up while keeping baseline distress scores constant. In Model 4, we adjusted for the baseline measure of deprivation complementary to each analysis: the association between material deprivation change and distress adjusted for baseline social deprivation, and vice versa.

2.3.1 Sensitivity analyses

To account for potential data autocorrelation we also adjusted for province of residence in our models, but found no effect (results not shown). Furthermore, to make up for the potential loss of information and detail in our classification method of

deprivation change, wwe also ran all four regression models listed above using an alternative classification of deprivation change. In these models, a 1-quintile change was considered a small change, whereas a 2 or more-quintile change was considered a large change in deprivation. We tested the effects of these changes on distress in reference to those who experienced no change in quintile of deprivation. These models were also stratified by baseline deprivation (low-medium/high). Statistical analyses were conducted using STATA, version 13.

2.4 Ethical approval

Ethics and study design for the NPHS study was originally approved by Statistics Canada. For this study, the use of confidential survey data collected by Statistics Canada was carried out at the Quebec Inter-university Center fo Social Statistics at the *Université de Montréal* under Statistics Canada's stringent procedures for disclosure analysis. These procedures assured that no individual was identifiable as a result of the research. Researchers AB and GG received security clearance and took the Statistics Canada oath in order to access the confidential NPHS data files.

RESULTS

3.1 Descriptive statistics

At baseline (Appendix C: Table 1), the average age of our sample was of 53 years, 56% were women and the majority of the sample were married, Caucasian, had a medium to high level of income adequacy, were employed, and achieved a high-school education or higher. The average distress score was of 0.67, which is comparable to the Canadian national average for women (0.67 CI 0.66-0.68) and for men (0.61 CI 0.59-0.62) [95].

3.2 Patterns of neighborhood change

The type of neighborhood change experienced by study participants between 2000 and 2006 is diverse (Appendix C: Table 1). When looking across types of material deprivation change, we observe that 43% of the sample lived in neighborhoods of stable affluence, 39% lived in neighborhoods that remained at high levels of deprivation, and

9% of participants either lived in neighborhoods that improved materially over the six year period, or worsened. Participants were mostly similar across the four types of material deprivation change. However, a greater proportion of participants living in neighborhoods with constant low to medium deprivation levels tended to have achieved post-secondary education compared to the other groups. A greater proportion of participants living in neighborhoods with constant high deprivation levels tended to have low income adequacy.

The distribution of sample participants across types of social deprivation change is slightly different. A majority of participants lived in neighborhoods with constant levels of low to medium social deprivation (60%), while 24% of participants lived in neighborhoods with constant levels of high social deprivation. A similar proportion of participants experienced worsening and betterment of neighborhood social deprivation levels (8% for both). A greater proportion of participants living in neighborhoods with constant low to medium levels of deprivation tended to be married compared to the other three categories. A greater proportion of participants living in neighborhoods with constant levels of high deprivation were unemployed.

3.3 Associations between material deprivation change and distress

Table 2 (Appendix C) describes the relationship between material deprivation change and distress outcomes at follow-up. For persons living in neighborhoods with high deprivation at baseline, an improvement in neighborhood material conditions was not significantly associated with distress outcomes at follow-up. For persons living in neighborhoods with low levels of material deprivation at baseline, a worsening of material deprivation was significantly associated with increasing distress scores at follow-up, when controlling for individual socio-economic and demographic characteristics. This association remained significant after controlling for baseline distress scores.

3.4 Associations between social deprivation change and distress

As demonstrated in Table 3 (Appendix C), study participants who lived in high deprivation neighborhoods at baseline which became less socially deprived by follow-up

experienced increases in psychological distress. This association remained positive after controlling for baseline distress scores, but the confidence interval slightly shifted to cross the null. Living in a worsening social environment was not significantly associated with psychological distress scores at follow-up, compared to the reference group of those living in neighborhoods that stayed constant in their level of low to moderate social deprivation.

3.5 Sensitivity analysis

After conducting sensitivity analyses with alternative classifications of deprivation change, we found no significant association between small or large changes in material deprivation and distress scores at follow-up compared to no change (Appendix C: Supplementary Table B). When examining alternative classification of social deprivation change, we observe that a large improvement in social conditions (i.e. 2 quintile jump between baseline and follow-up) was significantly associated with an increase of distress scores at follow-up (Appendix C: Supplementary Table C). There was no significant association between a small improvement (i.e. 1 quintile change) and distress, nor was there a significant association between small or large worsening of social deprivation and distress.

DISCUSSION

This study achieved its first objective of offering a cursory description of the types of neighborhood deprivation change experienced by the study sample between 2000 and 2006. Given our classification of deprivation change, the majority of participants lived in neighborhoods that did not change drastically in social or material deprivation level during the six years between baseline and follow-up.

Nearly 40% of participants lived in neighborhoods with constant high levels of material deprivation. Exposure to high levels of material deprivation is alarming for social geographers and public health officials, insofar as material deprivation, and the

vulnerability associated with it, has been observed as a risk factor for health conditions beyond psychological distress [87, 96].

Insofar as neighborhood improvement is of particular interest for public health, it is noteworthy that only 9% of participants lived in neighborhoods that improved materially, and 8% of participants lived in neighborhoods that improved socially over time. The relative stability of neighborhoods has been observed in other studies, wherein deprived neighborhoods that are left alone without institutionalized, planned redevelopment or reinvestment programs do not improve on their own. Economic and social systems tend to keep highly materially deprived neighborhoods locked in a context of disadvantage [97]. That being said, due to the ecological nature of the data, we did not have access to information regarding urban planning programs in the metropolitans areas of Canada in our time period. It is therefore possible that interventions were indeed taking place. Unfortunately, it is beyond the scope of our data to comment on the causality of potential interventions strategies.

The second objective of this study was to compare the psychological distress outcomes across various types of neighborhood change. We found that, even after controlling for individual covariates, two types of neighborhood deprivation change were significantly associated with distress scores at follow-up. Both the improvements of social settings, and the worsening of material or economic settings, were associated with higher distress scores. Many interpretations may be able to explain these seemingly contradictory observations. The accompaniment of higher distress scores with a sharp worsening of socioeconomic environment is consistent with findings from other studies that have reported worse affective health outcomes in response to unplanned changes of neighborhood socioeconomic circumstances [69, 73]. Studies which have examined cross-sectional neighborhood exposure suggest that materially disadvantaged neighborhoods restrict the formation of protective social ties and support networks [42], expose residents to multiple, chronic stressors [37, 46], decrease residents' access to adequate service provision and housing [98], and reduce access to health-promoting and coping resources [99]. It is plausible that rapid decrease in

economic affluence over a six year period maybe have affected distress scores through the latter mechanisms. Future research is required to test modifiable causal pathways.

In seeming contradiction to latter finding, we observed a worsening of distress scores among residents living in neighborhoods that experienced an improvement in social circumstances—especially those who experienced a large improvement. This improvement, as measured by a change in quintile grouping according to the Pampalon Social Deprivation Index, suggests a shift in the social vulnerability of these neighborhoods. In a six year period, there were fewer single-parent families, fewer people living alone, and fewer people who were single, widowed, or divorced living in these neighborhoods. Unfortunately, we have no information about what may be driving these changes—for example, it may be that there were fewer families living there altogether, or more students or younger adults sharing apartments, and thus reporting shared residential status in census questionnaires. This lack of information is an important limitation which future studies must address. Without these details, we may only propose certain theoretical interpretations. One possible explanation is the process of gentrification. Gentrification has been defined in many ways. One material definition suggests it is the process through which areas of lower income, and lower-value housing are transformed, and lower-income, racialized families are replaced by middle- or upper-class residents [100]. A more social definition is that gentrification is “the movement of young, often single, professionals into low-income, heavily minority, neighborhoods near urban employment centers” [101]. Gentrification, defined as these social and economic changes, has been occurring in Canadian cities for decades [83, 102, 103]. However, it has mostly been studied in the United Kingdom and the United States [100]. Currently, no published review has examined the effects of gentrification on mental health in Canada. Without existing Canadian studies in this area, we can only hypothesize why distress scores are worsening in neighborhoods that are showing less social deprivation. It is hypothesized that neighborhood gentrification can impact the mental health of long-term residents by affecting their sense of exclusion [104], reinforcing perceptions of social hierarchies [83], and disrupting protective social ties [105]. These pathways are known to affect psychological symptomatology such as depressive symptoms [23]. Given the current trends of urbanization in Canada [35], of

neighborhood income-segregation [106], and the important burden of mental health issues on the Canadian population [36, 107], there is a need to evaluate the relationship between urban gentrification and mental health outcomes in future research—especially social trends in urban population change. Furthermore, it could be argued that a change in social deprivation is only a proxy for gentrification measurement. Thus, future research would also gain from a more explicit measurement of gentrification using census, business, and taxation data.

4.1 Limitations and strengths

The observations described above are restricted by certain limitations. First, by focusing on a sample that did not move for at least a six year period, we are restricting the representativeness of our sample. Moving and unstable living environments has been demonstrated to be correlated with lower SES [87], and is associated with worse mental health outcome. Future studies should examine the mental health impacts of moving away from a neighborhood following neighborhood change. Similarly, by excluding rural residents from our sample, we are limiting the generalizability of our sample. Secondly, our sample is relatively small for this type of study. Future research would benefit from a sampling technique that allowed for a greater statistical power in examining neighborhood change—especially for the more rare patterns of neighborhood improvement and worsening.

Thirdly, the transition between categories of low-medium deprivation and high deprivation includes a heterogeneous range of changes. For example, a change from 1st quintile to 5th is not differentiated from a transition from the 3rd to the 4th. We attempted to adjust for this limitation in our sensitivity analyses. We acknowledge that by separating the scores into quintiles, our classification of which neighborhoods are considered “low-medium derivation” or “high deprivation” depends on what data make up these quintiles, and are thus not constructed in reference to an absolute measure of social or material deprivation. Low-medium deprivation and high deprivation classifications are thus relative classifications. This was a first attempt at describing the association between neighborhood change and psychological distress. Future research

would gain from more complex models of analysis, or alternative modes of quantifying deprivation change.

Fourthly, a limitation is the six-year timeframe of our study. It is unclear how much neighborhoods can indeed change in such a time period. Future studies should consider extending the scope of the timeframe beyond 6 years to capture more long-term patterns of neighborhood change, and mental health change.

A fifth limitation is that the deprivation index we used relies on census-based, aggregate, ecological-level data, which may not fully capture all aspects of deprivation such as community involvement, social networks, or support systems. Using aggregate data to describe neighborhood contexts, we do not have information about individual-level exposures such as how much time is spent in their neighborhoods per day, or what kind of services or resources are available and accessible to each person. We also do not know exactly what is driving ecological changes in deprivation, and this incomplete knowledge of population dynamics is a limitation of this study. Furthermore, though we adjusted for known demographic covariates, future research could benefit from addressing other potential, unmeasured confounding factors such as time spent in the neighborhood or the number of small children in the home. Lastly, we did not have access to area-level data on racial or age composition, nor did we look at other measures of neighborhood environments such as neighborhood mobility, which in future studies could be controlled for to minimize residual confounding.

Despite these important limitations, this study bears certain strengths. First, the use of a longitudinal data set allows us to comment on the potential causal linkages between neighborhood change and distress outcomes. Second, by focusing on an urban sample, this study increases the potential for comparability between neighborhoods-level observations. Third, by using a clinically-validated mental health measure of psychological distress, this study increases the rigor, reproducibility, and comparability of its results. Fourth, the Pampalon Deprivation Index offers an objective measure of neighborhood social and material deprivation. This limits the issue of information bias if participants were to also report on their neighborhood environments.

4.2 Implications for research

This study is a first foray into the measurement of neighborhood change and associated psychological effects. As a first attempt at categorizing and measuring the effects of Canadian neighborhood deprivation change, this study suggests that both worsening material conditions and improving social conditions, when unplanned and caused by systematically occurring shifts in economics, politics, and social environments, are associated with worsening psychological distress outcomes. This should be acknowledged by urban municipalities in Canada, and taken into account in future Public Health policy, interventions, and research.

Future studies could benefit from an investigation of alternative classification methods of neighborhood change, or the examination of other timeframes, such as change occurring after the economic recession of 2008. Future studies should examine naturally-occurring experiments of neighborhood change and examine their effects on mental health outcomes such as psychological distress. Socioeconomic vulnerability and the strength of social ties in neighborhood contexts is a relevant topic of investigation.

Conflicts of Interest

The authors declare that there is no duality of interest associated with this manuscript.

CONCLUSION AND SUMMARY

PRINCIPLE FINDINGS

The present thesis aimed to unpack the relationship between neighborhoods and mental health. In the first literature review (Manuscript 1), we observed that neighborhood disorder, crime, social ties, and economic deprivation were all shown to affect depressive symptoms in adults. We also identified the potential modifiable pathways explaining these associations that were proposed in the literature. It is possible that crime, disorder, and economic deprivation affect depressive symptomatology by shaping the level of stress placed on individuals, and by influencing their (potentially negative) perceptions of neighborhood aesthetics. Moreover, neighborhood social capital might affect depressive symptomatology by improving the level of resiliency to negative affectivity and stress, and by determining individuals' sense of social control, political agency, and sense of hopefulness within their community.

In our second review (Manuscript 2), we asked if changes in neighborhood environments affect mental health. We found that neighborhood change is either planned or systematically occurring due to shifts in existing economic, social, and political landscapes. Despite heterogeneous results, most studies reported that neighborhood change was indeed associated with adult residents' emotional affectivity. Increases in neighborhood disorder over time led to more stress and worse mental health outcomes, particularly for lower SES residents. Furthermore, most economic regeneration interventions that aimed to improve aesthetics and infrastructure were associated with increases in well-being. However, certain forms of urban renewal were not well received. For example, certain regeneration programs that were not explicitly planned to improve mental health had negative effects on well-being because they disrupted social ties, increased isolation, and had negative impacts on employment.

Having summarized existing literature on neighborhood change and mental health, we tested the association in a Canadian setting (Manuscript 3). Using psychological distress data from the National Population Health Survey and neighborhood deprivation data from the Pampalon Index, we found that even after controlling for individual risk

factors, both an improvement of social settings and a worsening of material settings were associated with worsening distress scores at follow-up. We proposed that the process of gentrification and social renewal—phenomenons largely studied in fields of urban geography, sociology, and urban planning—might play a role in unpacking the observed mental health outcomes. Neighborhood changes may affect resources, services, as well as social exclusion and social fragmentation, which all may have an impact on the affective symptoms of long-term residents.

THESIS IMPLICATIONS AND NEXT STEPS

The findings from this thesis have important implications for neighborhood-level research, as well as fields of public health and urban design. Our findings imply that more rigorous neighborhood-level research is needed to understand the linkages between neighborhood spaces and psychological well-being. More specifically, future neighborhood-level research should test the identified causal pathways linking neighborhood characteristics to mental health outcomes. Additionally, incorporating a more dynamic, time-varying understanding of neighborhoods is essential for understanding distal environmental determinants of mental health. The systematic use of longitudinal design and a diversity of physical and social environmental measure will also be needed. Current observational research studies are limited in scope. Future directions for this area of research include quasi-experimental research designs, randomized control trials, pre- and post-intervention evaluations of regeneration programs, and longitudinal studies of people living in rapidly gentrifying neighborhoods.

From a public health perspective, it will be important for future research to both develop a more thorough explanation of the ways in which interventions can be designed, and systematically test the effects of neighbourhood-level interventions on mental health. For example, if social ties improve affective resiliency, how do we improve social ties within a community? Neighborhood environments could potentially be optimized to promote mental health and prevent affective symptoms. Currently, however, we have few studies to rely on to propose effective strategies of neighborhood optimization. Our systematic review suggests that holistic regeneration programs aimed at improving the health of current vulnerable residents by affecting several intersecting

aspects of the neighborhood environment, such as social, political, economic, and physical landscapes, appear to be promising tactics. Our research suggests that areas of intervention include: 1) the protection against individual-level economic vulnerability as well as population-level economic deterioration; 2) social support programs for long-term residents of neighborhoods experiencing social renewal and migration; and 3) the physical improvement of neighborhood infrastructure, safety, and easthetics. Most importantly, in order for these interventions to be effective, it will be beneficial to create interdisciplinary research partnerships between clinicians, epidemiologists, urban planners, and community stakeholders. Neighborhoods are complex social, physical, economic, and political spaces. Our future interventions must capture the complexity of neighborhoods if they are to succeed in reducing health inequalities and promoting mental health.

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APPENDICES

APPENDIX A: TABLE FROM MANUSCRIPT 1

Table 1 Summary of the 14 longitudinal studies included in the realist review

APPENDIX B: TABLES FROM MANUSCRIPT 2

Table 2 Critical appraisal of studies included in the review

Table 3 Results from qualitative studies

Table 4 Results from quantitative studies

APPENDIX C: TABLES FROM MANUSCRIPT 3

Table 1: Baseline descriptive statistics of study sample, stratified by categories of material and social deprivation change

Table 2: The effects of neighborhood material deprivation change on psychological distress

Table 3: The effects of neighborhood social deprivation change on psychological distress

Supplementary tables

Table A: Baseline demographic characteristics of non-movers in study sample and movers excluded from the study sample

Table B: The effects of neighborhood material deprivation change on psychological distress, sensitivity analyses

Table C: The effects of neighborhood social deprivation change on psychological distress, sensitivity analyses

APPENDIX A: TABLE FROM MANUSCRIPT 1

Table 1: Summary of the 14 longitudinal studies included in the realist review

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighb. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Beard et al. 2009	1325 (aged 50+)	2005-2007 (2 yr. follow-up)	62%	New York City, USA: Census Tracts	*SES:* % high school graduates, % with undergraduate degrees, annual income, occupation, % unemployed, % Latino/ Black, % living in poverty, % owner-occupied dwellings, % living in same house for 5 yrs., density, % foreign born	Past 2 wk. depression assessed using PHQ-9: 10 cut-off score	Models adjusted for: baseline depression, age, race, gender, marital status, education, income, employment, physical activity, BMI, social support	Multilevel models; Bivariate and multivariate regressions	Neighb. affluence remained strongly protective against worsening of depression symptoms; Borderline evidence also shows that disadvantage increases risk of worsening depression	Affluence increases resiliency to stressors	Structural interventions targeted toward improving health of older persons

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Buu et al. 2011	273 white women; caregiver or mother (average age 31)	1980-2000 (12 yr. follow-up)	60%	Michigan, USA: Census Tracts	*1) Socioeconomic Disadvantage: %* adult unemployment, % poverty *2) Residential instability:* % residents living in different residence 5 year ago, % vacant households, % rented housing units	Past week assessment using the Hamilton Rating Scale for Depression: 20+ score indicates moderately severe depression	Models adjusted for: baseline past-year, current and lifetime depression, age, marital status, alcohol use, social support, antisocial behaviour, family SES, family stress	Linear mixed modeling	1) Baseline depression and low SES predicted future depression. Depression increased with age; 2) Neighb. instability associated with higher depression, controlling for individual factors; Neighb. disadvantage did not have a statistically significant effect	Instability hiders the formation of social cohesion, and weakens the willingness of individuals to intervene for the common good; Collective efficacy mediates alcohol problems and depression	Improve social support systems, educational or professional training opportunities, the accessibility of family counseling, and the neighb. environment by providing support networks, building community institutions

Table 1 (Continued)

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Cutrona et al. 2005	897 Black mother or care-giver of 10-12 yr-old child (aged 24-80)	1997-1999 (2 yr. follow-up)	88%	Non-inner city or urban areas of the United States: Census Bureau Block Group Areas	*1) Economic Disadvantage:* average per capita income, % female-headed households, % on public assistance, % households below poverty level, % unemployed men *2) Social disorder (perceived):* delinquency, use of drugs, garbage, public drinking, gang violence	Past-yr. assessment using Michigan University Composite International Diagnostic Instrument (UM-CIDI)	Models adjusted for baseline and lifetime depression, education, age, reception of government assistance, number of children, employment, income, number of past-year negative life events, personality traits	Hierarchical multilevel logistic regressions	Neighb. disadvantage and social disorder predicted onset of major depression, even when controlling for individual variables; The latter relationship was only marginally significant when controlling for negative life events	Having few economic opportunities and few role models for economic success undermines optimism and belief in personal mastery, undermines recovery from negative events, and affects family dynamics; Disorder inhibits supportive relationships, prevents predictability, and threatens physical safety	None

Table 1 (Continued)

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Curry et al. 2008	786 (mean age 39)	1997-2002 (3 yr. follow-up)	87%	Baltimore, USA: Census Bureau Block Group Areas	*1) Objective Disorder:* City Police crime data on violent, or person-to-person crimes (assaults, murders, rapes, robberies); *2) Subjective Disorder:* perceived vandalism, litter, vacant housing, loitering	Past week depression assessed using 20-item CES-D scale: 16+ cut-off score; was measured at follow-up	Models adjusted for gender, education, employment, age, partner status, injected drug use, personal experience with crime and violence in past year	Correlation analysis; Path model analysis	Not a direct path between neighb.-level of violent crime and depression; Crime was associated with CES-D through 1) perceptions of neighb. disorder and 2) through experiences of violence in the neighb.; Correlation between perception of disorder and violent crime	Less available social support and social resources affects health. Violence is associated with lower social capital; Fear of crime and violence leads to few between-people interactions and disorganization, which impede social capital	Community-wide violence prevention interventions: stricter enforcement laws, increased police presence, neighb. watch groups, surveillance cameras, and street cleaning

Table 1 (Continued)

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Galea et al. 2007	1020 (aged 18+)	2002-2003 (6 & 18 month follow-up)	81%	New York City, USA: NYC Com-munity Districts	*Socioeconomic status:* dichotomized along median split of median household income	Lifetime, past 6 month MD assessed using Modified Structured Clinical Interview (DSM-III): cut-off of 5+ symptoms for two straight weeks	Models adjusted for past-6 months, current and lifetime depression, age, sex, race education, income, marital status, social support, directly affected by 09/11, PTSD	Multilevel multivariate models; Cox Proportional Hazards analysis	Respondents residing in lower SES neighbs. had more than 2 times of developing depression during follow up relative to those living in high-SES areas; Women had greater risk for incident depression than men	In low-SES neighbs. there are more stressors, less material and social resources; people are more likely to experience trauma, and are more vulnerable. Limited social cohesion diminishes capacity to control disorder; Exposure to disorder may result in psychological stress	If the relation between urban neighb. poverty and depression is mediated by signs of physical disorder, interventions could address vandalism and trash in urban areas
Glymour et al. 2010	4000 (aged 55 to 65)	1992 to 2006 (10 year follow-up)	90%	United States: Census Tracts.	*Disadvantage:* % high school graduates, % male unemployment, % poor households, % female heads of household, median household income.	Past week depression using 8-item CES-D scale: 3+ cut-off score.	Models adjusted for baseline depression, race, sex, education, household wealth, marital status, employment	Logistic regression	Residence in a dis-advantaged neighb. did not predict onset of elevated depressive symptoms	No relationship observed	None

Table 1 (Continued)

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Kim 2010	2482 (aged 18-92)	1995-1998 (3 year follow-up)	54%	Illinois, USA: Census Tract	*1) Perceived Disorder:* social relationships, neighb. social ties, social support *2) Disadvantage:* % female-headed households, % poverty households	Past week depression assessed using 20-item CES-D scale: 16+ cut-off score	Models adjusted for baseline depression, age, race, education, household income, marital status, urban/rural residence	Structural equation modeling	Residents living in low SES neighbs. are more likely to be more depressed; Disorder mediates the latter relationship; Social ties reduce feelings of depression, but do not completely mediate the relationship between disadvantage and depression	(1) Neighb. disadvantage increased depression directly, (2) neighb. disadvantage increased depression by way of neighb. disorder, and (3) neighb. disadvantagedecreased depression by way of enhanced social relationships	None

Table 1 (Continued)

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Latkin et al. 2003	818 mostly low-SES adults, pop with high levels of substance abuse (mean age 39)	1997-1999 (9 month follow-up)	72%	Baltimore, USA: Baltimore City Block	*Perceived Disorder:* perceived problems of vandalism, litter, trash, vacant housing, teenagers hanging out, burglary, drug selling, and robbery	Past week depression assessed using 20-item CES-D scale: 16+ cut-off score	Models were adjusted for baseline depression, social support, social integration (having partner attending church), gender, marital status, housing status, income, drug use, criminal history, education	Spearman Correlation matrix; Linear Regression Models	Higher frequency of church attendance, high education and male gender all associated with lower depression scores; Worse perceptions of neighb. significantly associated with higher depression at follow-up, even after controlling for individual factors	Chronic, ambient stressors (e.g. social disorganization) affect sense of controllability (of litter, crime); Even with high levels of social support, the networks are so impoverished that they cannot reduce neighb. stressors	Allowing individuals to regain social control through community organizations; Provide training and employment opportunities outside of the drug economy, reduce the physical decay and destruction, and provide adequate housing and social services
Lofors et al. 2006	4.5 million (aged 25-64) Swedes followed from 1997 until first hospital admission due to depression.	1997-1999 (2 year follow-up)	97%	Sweden: Small Area market statistics	*1) Linking social capital:* mean voting participation. *2) Deprivation:* % with low-educational status, % unemployment, % elderly people living alone, number children under age 5, single parents, mobility, % foreign born people	First hopsitalisation due to depression classified according to Inter. Classification of Diseases (ICD9 and ICD10) by a clinical psychologist	Models were adjusted for age, gender, housing tenure, employment, education, marital status, country of birth	Multilevel logistic regression	Depression rates increased when linking social capital decreased and neighb. deprivation increased; The association between social capital and depression no longer significant after adjusting for neighb. deprivation	Poor social networks result in a lack of social support, isolation, and political and social powerlessness, which in turn increases vulnerability to depression	Decision makers should take into account the evidence of neighb. effect on mental health in decisions regarding sites of psychiatric clinics and community support services for psychiatric patients

Table 1 (Continued)

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Santiago et al. 2011	136 parents or guardians (mean age 34)	2002-2004 (2 year follow-up)	70%	Denver, Colorado: Zip Code	*Structural Disadvantage:* levels of poverty, unemployment, educational attainment, residential mobility	Past six month assessment using Achenbach System of Empirically Based Assessment Adult Self Report Question-naire	Models were adjusted for baseline depression, occupation, education, age, sex, race, family poverty-related stress, and both affective, and behavioural characteristics	Hierarchical linear mode	Disadvantage predicts psychological syndromes; Instability is harmful for adults. Poverty predicted more social problems and affected psychological functioning; Unemployment related to fewer social problems and fewer depressive symptoms	Residential mobility and high poverty rates reduce a community's ability to exercise social control through strong social ties; They also reduce interconnectedness within and commitment to the community	Consider childcare, employment, family resources; Advocate for area improvement initiatives, programs that encourage cohesion and investment, and more resources for low-income families

Table 1 (Continued)

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Schoot-man et al. 2006	998 African Americans (aged 50+)	2000-2004 (3 year follow-up)	90%	St-Louis County, MO, USA: Census tracts.	*Deprivation index: 1) Disadvantage:* % below poverty line, % on public assistance, % age 25+ with less than high school, % housing units lacking plumbing, % black, % unemployed. *2) Residential stability:* % residing over 5 yrs., % owner-occupied housing. *3) Social disorganization:* % female-headed households, % aged 64+	Past week assessment using 11-item CES-D scale: 9+ cut-off score	Models adjusted for baseline depression, gender, income, inadequacy, limits in vision, underweight or obesity, past-year hospitali-zation, social support, medical conditions, use of health services, use of anti-depressant	Two-level logistic regression models	No association between any observed attribute of subject location and development of depression	No relationship observed	None

Table 1 (Continued)

Author, Date	Sample size, age	Follow-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Stafford et al. 2011	8780 (aged 50+)	2002 to 2005 (2 year follow-up).	82%	England: English Longitu-dinal Study of Aging primary study cluster units	*1) Social cohesion:* sense of belonging, perception of trust, perception of solidarity and friendliness, perception of reciprocity *2) Safety:* problems with vandalism and graffiti, perceived safety while outside after dark, sense of helpfulness of neighbours	Past week assessment using 8-item CES-D scale: 3+ cut-off score	Models adjusted for baseline depression, age, gender, sense of friendship, sense of control, total wealth, occupation and marital status	Structural equation modeling	Greater neighb. social cohesion associated with fewer depressive symptoms at follow-up	Social cohesion mediates potential negative impacts of friendships and enhances personal sense of control; Environments with low cohesion also likely to be multiply disadvantage d; Socially cohesive environments are thought to be more conducive to supportive social relations	Interventions that foster neighb. social cohesion

Table 1 (Continued)

Author, Date	Sample size, age	Follo w-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Weich et al. 2005	7659 adults (aged 16-74)	1991-1992 (12 month follow-up)	80%	United Kingdom: Electoral Wards	*Socio-economic deprivation:* (Using the Carstairs Index) % male unemployment, households with no car, % overcrowding, head of household in lower social class	Last few week assessment using 12-item General Health Question-naire: score of 3+.	Models adjusted for baseline depression, age, gender, marital status, financial strain, health problems, household overcrowding and type, tenure, and problems. Occupational social class, household income, car access	Multilevel models; Bivariate and multivariate regressions	Maintenance, but not episode onset, was significantly increased among those living in most deprived areas; These results did not reach statistical significance after adjustment for individual and household characteristics ; Household variables did not have an effect on depression outcomes	No relationship observed	None

Table 1 (Continued)

Author, Date	Sample size, age	Follo w-up Period	Follow-up Rate	Location, Neighbor-hood. Unit	Neighb.-level Variable Measured	Depression Measure	Adjustment for Covariates	Statistical Methods	Key Findings	Proposed Causal Mechanisms	Future Policy/ Interventions?
Wight et al. 2009	3442 (aged 70+)	1993-1998 (5 year follow-up)	55%	United States: Census Tracts	*1) Socioeconomic disadvantage:* % residents aged 25+ without high school degree. % households receiving assistance, % residents living below poverty line, % residents aged 16+ unemployed, % residents 65+ *2) Affluence:* % households with $50,000 incomes *3) Racial/ethnic composition:* % residents who are black, % residents who are Latino	Past week assessment using 8-item CES-D scale: 3+ cut-off score	Models adjusted for baseline depression, education, household income, gender, age, ethnicity, marital status, religions, assistance with activities of daily living, heart problems, stroke, count of other major medical conditions, cognitive function	Hierarchical linear models	Change in depressive symptoms significantly associated with low neighb. SES and ethnic composition in unadjusted models, but not in models that control for individual-level characteristics; There is a statistically significant protective effect for Hispanics living in high-density and deprived Hispanic neighbs	With extended aging, neighb. conditions are so distal to the individual's own health circumstances that the environmental ''press'' may reach a plateau in late life; neighb. disadvantage may affect well-being only for those who are most weighed down by poverty	None

Table 1 (Continued)

APPENDIX B: TABLES FROM MANUSCRIPT 2

Table 2: Critical appraisal of studies included in the review

CASP Qualitative checklist	*Clear statement of aims?*	*Is qualitative methodology appropriate?*	*Is research design appropriate to address aims of the research?*	*Was recruitment strategy appropriate to the aims of the research?*	*Was the data collected in a way that addressed the research issue?*	*Has the relationship between researcher and participant been adequately considered?*	*Have ethical issues been taken into consideration?*	*Was the data analysis sufficiently rigorous?*	*Was there a clear statement of findings?*	*How valuable is the research?*	*Total Score (Yes=2, Unclear =1, No=0)*	*Strength of the quality of the study? (Poor=0-10 Moderate=11-15 Strong=16-20)*
Beck, 2010	Yes.	Yes.	Yes.	Unclear.	Yes.	No.	Yes.	No.	Yes.	Unclear.	14	Moderate
Burns, 2012	Yes.	Yes.	Yes.	Yes.	Yes.	No.	Yes.	Yes.	Yes.	Yes, Valuable.	18	Strong
Rogers, 2008	Yes.	Yes.	Yes.	Yes.	Yes.	No.	Unclear.	Unclear.	Yes.	Yes, Valuable.	16	Strong
Whitley, 2005	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes, Valuable.	20	Strong

CASP checklist for Cohort studies	*Did the study address a clearly focused issue?*	*Was the cohort recruited in an acceptable way?*	*Was the exposure accurately measured to minimize bias?*	*Was the outcome accurately measured to minimize bias?*	*Have authors identified all confounders ?*	*Have they taken confounders into account in the design and/or analysis?*	*Was the follow up complete enough and long enough*	*How precise are results?*	*Do you believe the results?*	*Can the results be applied to the local population?*	*Do the results fit with other available evidence?*	*Total Score (Yes=2, Unclear =1, No=0)*	*Strength of the quality of the study? (Poor=0-11 Moderate=12-16 Strong=17-22)*
Dalgard, 1997	Unclear: No clearly stated objective, but see results table.	Yes.	Unclear: risk of reporting bias because based on self-reported data	Unclear: no clinically validated screening tool was used.	Unclear: what about race or life time mental health issues	Yes.	Yes.	Not very precise.	Yes.	Unclear.	Yes.	15	Moderate

CASP checklist for RCT	*Did the study address a clearly focused issue?*	*Was the assignment of patients to treatments Randomized ?*	*Were all of the patients who entered the trial properly accounted for at its conclusion*	*Were patients, workers, study personal blinded?*	*Were the groups similar at the start of the trial?*	*Aside from the experimental intervention, were groups treated equally?*	*How large was the treatment effect?*	*How precise was the estimate of the treatment effect? (CIs)*	*Can the results be applied to the local population?*	*Were all clinically important outcomes considered ?*	*Are the benefits worth the harms and costs?*	*Total Score (Yes=2, Unclear =1, No=0)*	*Strength of the quality of the study? (Poor=0-11 Moderate=12-16 Strong=17-22)*
Beeble, 2011	Yes.	Yes.	Yes.	Unclear.	Yes.	Yes.	Small.	Precise.	Unclear.	Yes.	Yes.	17	Strong

Modified Cochrane EPOC for quasi-experimental design	*Was there a clear research question and was this important and sensible?*	*Could a randomized design have been used?*	*Was the intervention independent of other changes over time?*	*Were there sufficient data points to enable reliable statistical inference?*	*Was a formal statistical test for trend correctly undertaken?*	*Was the primary outcome measure valid and reliable?*	*Was the intervention unlikely to affect data collection?*	*Were outcomes measured by blinded observers or were they objectively verified?*	*Does the data set cover all or most of the episodes of care covered in the study?*	*Was follow-up continued long enough for the primary outcome measure to show an impact and for sustainability to be demonstrated?*	*Total Score (Yes=2, Unclear =1, No=0)*	*Strength of the quality of the study? (Poor=0-11 Moderate=12-16 Strong=17-22)*
Jalaludin, 2012	Yes.	Unclear because of ethical concerns.	Yes.	Unclear.	No.	Yes.	Unclear.	No.	Unclear.	Yes.	13	Moderate
Blackman, 2001	Yes.	No.	Unclear.	Yes.	No.	Unclear.	No.	No.	Unclear.	Yes.	10	Poor
Huxley, 2003	Yes.	No.	Unclear.	Yes.	Yes.	Yes.	Unclear.	No.	Unclear.	Unclear.	14	Moderate

Table 2 (Continued)

Table 3: Results from qualitative studies

Author, Date	Title	Study Aim	Study Type (Data Collection)	Study Location	Study Population	Neighborhood Change: (Planned or unplanned) *What kinds of changes to neighborhoods are documented?*	Mental Health Outcome: *How are mental health outcomes measured?*	Key Themes: *Who is affected, in what contexts, in what ways?*	Implications for future neighborhood-level interventions or research
Burns, 2012	*Revisiting the role of neighborhood change in social exclusion and inclusion of older people*	To explore how older people are affected by socioeconomic and demographic changes to their neighborhoods.	Qualitative case study using semi structured face- to-face interviews.	Petite-Patrie and Notre-Dame-de-Grace neighbor-hoods of Montreal, Canada	30 autonomous and mobile older adults (aged 68-95) who had lived in neighborhood for at least 10 yrs.; and 10 stakeholders/key informants from community organizations.	UNPLANNED: Diversification of ethno-cultural profile, increase of luxurious boutiques on main streets, residential gentrification (condo construction, changing real estate values), influx of younger, more educated population.	Feelings of social exclusion and attachment to place are assessed.	***Who is affected?*** Changes mostly perceived by older people who left their homes more frequently for errands. People of lower SES most affected by changes in real estate value. Italian community of home-owners with tight social networks less negatively affected by changes than French-Canadian renters with disparate networks. ***In what context?*** Demographic, socioeconomic, tenure and commercial shift in their neighborhoods. ***In what ways?*** Neighborhood changes can make older individuals feel a sense of strangeness, insecurity, and social exclusion. Changes in retail type remove social spaces (e.g. Bingo Halls), making it difficult for people to socialize and leave their homes. Increase in property values make it difficult for family members of residents to settle in the neighborhood. Some white residents are negatively affected by the influx of racialized residents, while others embrace the cultural diversification. Renters are affected by fluxuating real-estate market. They do not have full agency of where they live, and thus feel a sense of social exclusion. Very few people reported economic exclusion.	**Future research** should consider how neighborhoods affect older residents who age in place, how gentrification affects social exclusion of older people, and how older communities are heterogeneous in composition. **Future Interventions** should attempt to protect social spaces for older residents.

Author, Date	Title	Study Aim	Study Type (Data Collection)	Study Location	Study Population	Neighborhood Change: (Planned/Unplanned) *What kinds of changes to neighborhoods are documented?*	Mental Health Outcome: *How are mental health outcomes measured?*	Key Themes: *Who is affected, in what contexts, in what ways?*	Implications for future neighborhood-level interventions or research
Rogers, 2008	*More than jobs and houses: Mental health, quality of life, and the perceptions of locality in an area undergoing urban regeneration.*	Observe relationship between lay perceptions of locality adversity, mental health and social capital in an area undergoing urban regeneration.	In-depth face-to-face qualitative interviews.	South Manchester, England	20 adults who were participants in a larger longitudinal survey, and between the first and second stages of interviews had significant changes in Clinical Interview Schedule scores: 12 females, 8 males; average age 43 yrs.	PLANNED: Urban Regeneration Programme of South Manchester: aimed at improving infrastructure (housing, employment, transport).	Mental health assessed through GHQ-12 (psychosocial well-being), MANSA (life satisfaction), and GP use as part of a broader qualitative interview.	***Who?*** Women felt more threatened than men, and newcomers more affected than established residents. ***In what contexts?*** People living in a disadvantaged neighborhood in Manchester, where urban regeneration program takes place. ***In what ways?*** Locality factors increased individuals' sense of vulnerability or resiliency. The following factors increased feelings of distress: 1) less neighborliness/safety (more vandalism, harassment), and in turn less social control, 2) few leisure opportunities, 3) perception of neighborhood decline, 4) perception of discrimination (especially in employment) based on neighborhood of residence, and 5) disappointment with superficiality of regeneration program. These factors decreased sense of opportunity, and increased feelings of entrapment. However, despite these downfalls, residents acknowledged that bettered transport improved general perceptions of quality of life.	**Future interventions** need to be non-superficial or cosmetic-only. They should attempt to improve the sense of place by bettering neighborhood reputation and decreasing threats to safety. Partnership between organizations that lead regeneration initiatives and residents need to be established first. Areas to work on: improve sense of security, increase leisure opportunities, improve image of locality, and restore faith in acting agencies.

Whitley, 2005	*Can urban regeneration programmes assist coping and recovery for people with mental illness?*	To investigate the impact an urban regeneration program can have on everyday functioning, coping and recovery for people with a mental illness.	Face-to-face interviews in participants' homes, and focus groups.	Gospel Oak neighborhood of London, England.	16 residents of Gospel Oak, living with a mental illness (as classified with a 16+ score on the CES-D scale). All were participants in an on- going longitudinal study: 9 males, 7 females.	PLANNED: 1998-2001 "Health Action Zone" intervention aimed at improving integration and security. Changes: external repairs, decorations, roofing, secure doors, refurbished sports pitch, street lighting upgrades, partnership board for community participation, new sports center built, renovation of community center and library, new doors and cameras for communal blocks, landscaping.	Mental health of participants initially measured using CES-D scale. Participants asked about the affective impacts of regeneration interventions.	***Who, and In what contexts?*** People living with mental illness in a disadvantaged neighborhood of London. ***In what ways?*** Interventions affect coping and everyday functioning, but are not sufficient for complete recovery. Safety interventions had the most important impact on people living with mental illness, as they facilitated coping with mental illness. Increase in quality and quantity of shared community spaces had mild, positive effect, as they helped curb anti-social behavior, and promote social involvement in community. Household repairs helped protect people from ambient noise, and diminished fear of break-ins. Interventions aimed at community involvement had no significant positive effect.	**Future research** should compare coping and recovery in a variety of neighborhoods undergoing different or no interventions, preferably using longitudinal design.

Table 3 (Continued)

Table 4: Results from quantitative studies

Author, Date	Title	Study Aim	Study Location	Study Design	Sample Population	Neighborhood Change: (Planned or unplanned) *What kinds of changes to neighborhoods are documented?*	Mental Health Outcome: *How are people psychologically affected?*	Confounders, Controls, Covariates	Statistical Methods	Size of effect	Key Themes: *Who is affected, in what contexts, in what ways?*	Implications for future neighborhood-level interventions
Beeble 2011	*The impact of neighborhood factors on the well-being of survivors of intimate partner violence over time*	Examine how neighborhood disadvantage may contribute to survivor's compromised well-being, in addition to the abuse women experienced.	Confidential Location; multi- site study in the Mid-West of the United States.	Randomized control trial with 4,8,12, and 18 month follow-ups. Intervention is group session of family-based advocacy for abused women and their children. Control is service as usual.	160 female survivors of intimate-partner violence, victimized by a current or ex-intimate partner in the 4 months preceding their involvement in the study, with a at least 1 child aged 5-12; most of lower SES, only half were employed.	UNPLANNED: Perceived neighborhood disorder (litter, trash, gang activity, racial slurs) was measured using a 15 item scale; change in neighborhood disorder was measured by subtracting baseline score from subsequent scores.	Depressive symptoms were measured using the 20-item Centre for Epidemiological Studies - Depression Scale (CES-D); Quality of Life was assessed using nine items derived from the Perceived Quality of Life Scale.	Physical and psychological abuse, well-being, education, employment status, adjusted monthly income, race, and depression assessment at each time point.	Multilevel modeling using time varying exposures; two-level hierarchical models, expectation-maximization algorithm.	1-unit higher neighborhood disorder score was associated with a .037- unit lower QOL score ($p<0.05$); Within- woman changes in fear of victimization explained the effects of perceived disorder on changes in women's depression over time. Disorder had a significant indirect effect on depression through change in fear of victimization (.017, $p = 0.05$).	**Who is affected, in what contexts, and what ways?** Change in neighborhood disorder was negatively associated with change in QOL, and this relationship was fully mediated by fear. While no direct relationship between change in neighborhood disorder and depression was detected, an indirect effect through survivors' fear was revealed.	**Future research:** could combine subjective and more sensitive objective measures to account for reporting bias of self-report disorder data, and could examine a larger, more generalizable sample. Future research questions involve the intersections of personal and community experiences of disorder, threat, and violence. **Interventions** could attempt to reduce the number of incivilities at a neighborhood level.

Author, Date	Title	Study Aim	Study Location	Study Design	Sample Population	Neighborhood Change: (Planned or unplanned) *What kinds of changes to neighborhoods are documented?*	Mental Health Outcome: *How are people psychologically affected?*	Confounders, Controls, Covariates	Statistical Methods	Size of effect	Key Themes: *Who is affected, in what contexts, in what ways?*	Implications for future neighborhood-level interventions
Blackman 2001	*Neighborhood renewal and health: evidence from a local case- study*	Study the effects of neighborhood renewal on mental health.	Neighborhood Renewal Area in the west end of Newcastle Upon Tyne in Northern England, where in 19993, 44% of housing was unfit for habitation.	Quasi-experimental: Longitudinal follow- up of a natural experiment, with baseline interview in 1992, and follow- up post-renewal in 1997.	394 adults (16 and over); predominantly white (97%).	PLANNED: Renewal included environmental improvements, external fabric repairs, refurbishment and some demolition of void dwellings, renovation grants for individual dwellings and security and road safety improvements. A decline in population occurred as people moved away during program.	Psychological distress (as a grouping of mental health problems including depression, anxiety): measured by asking questions about concentration abilities, sleeping, depressed mood, feelings of hopelessness, loss of appetite.	Acute respiratory symptoms, chronic respiratory symptoms, GP visits, out-patient visits, in-patient stays. Age, sex, household type, overcrowding, employment status, receipt of housing or tax benefit, un/waged household, car ownership, housing tenure, dwelling type, happiness with home, keeping warm, vermin, housing defects, perceptions of place, baseline and follow-up health.	Chi-square for cross-sectional data, McNemar's test for longitudinal data; bivariate analyses and multivariate analysis using logistic regression.	10% decrease in psychological distress scores in adults with one or more mental health problems after renewal (p=0.05).	**Who is affected and in what contexts, and what ways?** A respondent who perceives the area to be unsafe is significantly more likely to report one or more mental health problems (OR 2.35 (1.41-3.92)). Also, adults who lived in dwellings with serious draughts were more likely to experience mental health issues (OR 2.28 (1.41-3.69). As perceptions of safety and housing quality improved, improvements in mental health were observed. However, feelings of safety improved significantly, but community spirit declined.	**Future research** should examine the impact of neighborhood renewal on health-related behaviour such as smoking and parent-child relationships. **Interventions** aimed at tackling issues of safety and housing quality are important. Tackling local causes of poor physical and mental health are a prerequisite for community regeneration.

Table 4 (Continued)

Author, Date	Title	Study Aim	Study Location	Study Design	Sample Population	Neighborhood Change: (Planned or unplanned) *What kinds of changes to neighborhoods are documented?*	Mental Health Outcome: *How are people psychologically affected?*	Confounders, Controls, Covariates	Statistical Methods	Size of effect	Key Themes: *Who is affected, in what contexts, in what ways?*	Implications for future neighborhood-level interventions
Dalgard, 1997	*Urban environment and mental health: a longitudinal study.*	*Assess if change in the quality of neighborhoods affect mental health. Test selection hypothesis and stress hypothesis.*	Oslo, Norway	Cohort Study: Longitudinal study with 10-year follow- up, using mail questionnaire.	503 persons (19 yrs. and over)	PLANNED: Assessment by local administrations: improvement in social environment (new public school, playground, sports arena, park, activities for adolescents, shopping center with restaurant and cinema, and extension of subway line); Assessment pairs with respondents' assessments of change in neighborhood.	50 questions questionnaire to assess clusters of symptoms relating to anxiety, depression, somatization.	Baseline mental health, age, sex, relationship status, education, time lived in area,	Multivariate statistical analysis multiple regression, supplemented with ANOVA test to detect interaction effects.	Decrease in symptoms (-0.1, SD 0.33, p<0.01)	***Who is affected and in what contexts? In what ways?*** Those with symptoms at baseline are more likely to show symptoms at follow-up. Mental health improved among those who did not move, especially among persons educated, and not married at baseline. People who stayed longer in the neighborhood (5-6 yrs.) showed better somatization outcomes than people who stayed for shorter amounts of time. More improvements in mental health were observed among older people.	**Future interventions** should include better planning of towns and neighborhoods to reduce mental suffering. Neighborhood facilities offering possibilities for recreation and social activities are essential.

Table 4 (Continued)

Author, Date	Title	Study Aim	Study Location	Study Design	Sample Population	Neighborhood Change: (Planned or unplanned) *What kinds of changes to neighborhoods are documented?*	Mental Health Outcome: *How are people psychologically affected?*	Confounders, Controls, Covariates	Statistical Methods	Size of effect	Key Themes: *Who is affected, in what contexts, in what ways?*	Implications for future neighborhood-level interventions
Huxley, 2003	*Urban regeneration and mental health*	*Assess the impact of an urban regeneration project on mental health.*	Manchester, England.	Quasi-experimental: Longitudinal study with 22-month follow-up, using mail questionnaire. Includes control group from community with no renewal. Follow-up rate of 65% - younger, single males less likely to return for follow- up; index and control samples not affected differently by response rate.	1344 subjects, mean age 51, 52% male.	PLANNED: Urban regeneration programme of South Manchester, the "Wythenshawe Single Regeneration Budget," aimed at improving infrastructure and employment.	GHQ-12 used to assess mental health, MANSA used to assess life satisfaction, and GP use.	Baseline and 22-month follow-up: socio- demographic measures, and measures of health status and quality of life. Assessment of personal perceptions of improvements.	Independent sample t- tests for continuous data, chi-squared test for categorical data. Analysis of covariance between GHQ12 scores and health satisfaction, controlling for baseline measures. Changes in percentages over time assessed with McNamara's test. Random effects regression model used for predictors of mental health, with area x time interaction included in model.	No significant difference in mental health outcomes after intervention.	**Who is affected and in what contexts?** No mental health improvement was noted in regeneration area compared to control, and life satisfaction decreased. In general, owner- occupiers and private-renters had best mental health outcomes. Negative life events, area severity score (graffiti, litter), vulnerability score (death of loved one, divorce), and especially restricted opportunities (unable to work, move) associated with mental health issues. **More on the context:** The intervention was not designed to improve mental health, and therefore very little change was observed.	**Future studies s**hould examine the impact of "restricted opportunities" on mental health. Restricted opportunities can correspond to feelings of entrapment. Studies should follow people over a longer period of time, because it makes take longer for new opportunities to affect GHQ scores. **Future interventions** should address the main concerns of local residents as identified by potential surveys and interviews.
Jalaludin 2012	*A pre-and-post study of an urban renewal program in a socially disadvantaged neighborhood in Sydney, Australia*	To evaluate the impact of an urban renewal program on the health and well-bring of residents of a socially disadvantaged community	Socially disadvantaged community in south-western Sydney, Australia.	Quasi Experimental: Pre- and post-urban renewal intervention, with baseline interviews conducted in 2008 and follow-up interviews conducted in 2011, 8 months after intervention was completed.	28 householders; 71% women, 86% aged 18-54, 89% English-speaking, 82% not completed year 12 of schooling, 57% heads of single-parent families, 86% not working for income, 46% did not own a motor vehicle.	PLANNED: Internal upgrades and renovation of houses, external upgrades and renovation of houses and properties, social interventions such as community engagement activities, employment initiatives.	Psychological distress measured using the Kessler Psychological Distress Scale.	Age, sex, education level, employment, country of birth, languages spoken, aboriginality, length of neighborhood residence, persons living in household, number of children in household, BMI, drinking behavior, smoking, physical activity, and pre- and post-assessments of distress.	Fisher-Freeman-Halton Exact Test to compare independent proportions; paired chi- squared test to compare paired proportions.	33% more people felt safe walking at night ($p<0.01$), 46% more people felt aesthetics were improved ($p<0.01$).	**Who is affected, in what contexts, and what ways?** After the intervention, a greater percentage of householder reported that they felt safer walking in their neighborhood at night, but the difference in perceptions of safety was not significant; a non-statistically significant difference in distress prevalence was observed.	**Future research** should seek to follow up with participants at a later follow-up time. No discussion of intervention implications was included.

Table 4 (Continued)

APPENDIX C: TABLES FROM MANUSCRIPT 3

Table 1: Baseline descriptive statistics of study sample, stratified by categories of material and social deprivation change

		CATEGORIES OF MATERIAL DEPRIVATION CHANGE					CATEGORIES OF SOCIAL DEPRIVATION CHANGE				
VARIABLES	ALL N=2745	Constant Low-Medium Deprivation N=1172 (43)	Low-Medium to High Deprivation N=251 (9)	Constant High Deprivation N=1072 (39)	Change from High to Low-Medium Deprivation N=250 (9)	Test Statistic	Constant Low-Medium Deprivation N=1639 (60)	Low-Medium to High Deprivation N=227 (8)	Constant High Deprivation N=661 (24)	Change from High to Low-Medium Deprivation N=218 (8)	Test Statistic
Age, Mean (SD)	52.79 (13.96)	53.96 (13.75)	52.30 (13.46)	51.66 (14.15)	52.69 (14.28)	0.0014	51.42 (13.53)	53.42 (13.07)	56.51 (14.58)	51.24 (14.08)	P<0.01
Sex, N (%)											
Men	1206 (43.93)	503 (42.92)	107 (42.63)	476 (44.40)	120 (48)		737 (44.97)	89 (39.21)	275 (41.60)	105 (48.17)	
Women	1539 (56.07)	669 (57.08)	144 (57.37)	596 (55.60)	130 (52)	0.487	902 (55.03)	138 (60.79)	386 (53.48)	113 (51.83)	P=0.121
Marital Status, N (%)											
Married	2029 (73.92)	856 (73.04)	191 (76.10)	782 (72.95)	200 (80)		1306 (79.68)	161 (70.93)	404 (61.12)	158 (72.48)	
Not Married	716 (26.08)	316 (26.96)	60 (23.90)	290 (27.05)	20 (40)	P=0.093	333 (20.32)	66 (29.07)	257 (38.88)	60 (27.52)	P<0.01
Race*											
Caucasian	2644 (96.39)	--	--	--	--	P= 0.096	--	--	--	--	P=0.399
Non-Caucasian	99 (3.61)										
Education, N(%)											
Post-secondary	974 (35.55)	541 (46.20)	82 (32.80)	269 (25.16)	82 (32.80)		597 (36.49)	69 (30.40)	234 (35.51)	74 (33.94)	
High school	1043 (38.07)	440 (37.57)	102 (40.80)	409 (38.26)	92 (36.80)	P<0.01	612 (37.41)	85 (37.44)	262 (39.76)	84 (38.53)	P=0.351
Less than high school	723 (26.39)	190 (16.23)	66 (26.40)	391 (36.58)	76 (30.40)		427 (26.10)	73 (32.16)	163 (24.73)	60 (27.52)	
Income adequacy, N(%)											
High	2312 (90.24)	1012 (92.59)	213 (89.50)	878 (87.45)	209 (92.07)		1404 (91.88)	188 (89.52)	533 (86.53)	187 (89.09)	
Low	250 (9.76)	810(7.41)	25 (10.50)	126 (12.55)	18 (7.93)	P=0.001	124 (8.12)	22 (10.48)	83 (13.47)	21 (10.10)	P=0.002
Past-year Employment, N(%)											
Employed	1788 (70.04)	759 (70.15)	167 (71.06)	692 (68.92)	170 (73.28)		1113 (71.90)	153 (71.16)	372 (63.70)	150 (72.82)	P=0.002
Not employed	765 (29.96)	323 (29.85)	68 (28.94)	312 (31.08)	62 (26.72)	P=0.598	435 (28.01)	62 (28.84)	212 (36.30)	56 (27.18)	
Baseline distress, Mean (SD)	0.67 (0.75)	0.64 (0.73)	0.70 (0.76)	0.68 (0.77)	0.74 (0.77)	0.246	0.66 (0.75)	0.60 (0.75)	0.69 (0.75)	0.76 (0.78)	P=0.099

* The large majority of participants were Caucasian, and this did not vary in relation to category of change. Because cell sizes of non-Caucasians were too small and could undermine confidentiality of survey participants, no sample size or % were reported in relation to categories of deprivation change.

Table 2: The effects of neighborhood material deprivation change on psychological distress*

	NEIGHBORHOOD IMPROVEMENT[a] VS. CONSTANT HIGH DEPRIVATION				NEIGHBORHOOD WORSENING[a] VS. CONSTANT LOW-MEDIUM DEPRIVATION			
VARIABLES	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 1	MODEL 2	MODEL 3	MODEL 4
Neighborhood change (Ref. no change)	0.003 (-0.05, 0.06)	0.06 (-0.05, 0.19)	0.02 (-0.09, 0.13)	0.02 (-0.09, 0.14)	**0.06 (0.01, 0.11)[c]**	**0.12 (0.01, 0.23)[c]**	**0.11 (0.01, 0.21)[c]**	**0.11 (0.01, 0.21)[c]**
Age (years)		**-0.01 (-0.01, -0.01)[b]**	**-0.01 (-0.01, -.002)[b]**	**-0.01 (-0.01, -0.002)[b]**		**-0.01 (-0.02, -0.01)[b]**	**-0.01 (-0.01, -0.01)[b]**	**-.01 (-.01, -.002)[b]**
Sex (Ref. Male)		**0.11 (0.2, 0.21)[c]**	0.08 (-0.01, 0.17)	0.08 (-0.01, 0.17)		**0.17 (0.08, 0.26)[b]**	**0.08 (0.01, 0.16)[b]**	**0.09 (0.01, 0.17)[c]**
Marital Status (Ref. married)		0.06 (-0.06, 0.18)	0.02 (-0.09, 0.13)	0.01 (-0.09, 0.12)		0.03 (-0.07, 0.13)	0.03 (-0.06, 0.12)	0.01 (-0.08, 0.11)
Race (Ref. Caucasian)		-0.02 (-0.27, 0.23)	-0.06 (-0.30, 0.17)	-0.06 (-0.30, 0.18)		0.09 (-0.12, 0.31)	-0.01 (-0.21, 0.18)	-0.01 (-0.21, 0.19)
Education (Ref. Post-sec.)								
High school		-0.03 (-0.16, 0.07)	-0.01 (-0.12, 0.09)	-0.01 (-0.12, 0.09)		0.03 (-0.06, 0.12)	0.004(-0.08, 0.09)	0.002 (-0.08, 0.09)
Less than high school		0.01 (-0.11, 0.14)	-0.01 (-0.13, 0.11)	-0.003 (-0.12, 0.11)		**0.20 (0.07, 0.33)[b]**	**0.20 (0.09, 0.32)[b]**	**0.21 (0.09, 0.32)[c]**
Income adequacy (Ref. Low)		-0.08 (-0.25, 0.09)	0.04 (-0.12, 0.19)	0.03 (-0.12, 0.19)		**-0.25 (-0.43, -0.06)[b]**	**-0.21 (-0.37, -0.04)[c]**	**-0.2 (-0.37,- .04)[c]**
Past-year employment (Ref. employed)		**0.17 (0.03, 0.30)[c]**	**0.14 (0.02, 0.27)[c]**	**0.14 (0.02, 0.27)[c]**		0.07 (-0.05, 0.19)	0.02 (-0.09, 0.13)	0.02 (-.09, 0.13)
Baseline distress			**0.39 (0.33, 0.45)[b]**	**0.38 (0.33, 0.45)[b]**			**0.41 (0.35, 0.46)[b]**	**0.41 (0.35, 0.46)[b]**
Baseline deprivation (Ref. Low)				0.06 (-0.03, 0.16)				0.08 (-0.01, 0.16)

* Distress scores were log transformed such that (log*(score + 1)).

[a] In the first four models, neighborhood change represents neighborhood improvement (e.g. change from high deprivation to low-medium deprivation), while in the last four models neighborhood change represents neighborhood worsening (e.g. change from low-medium deprivation to high deprivation).

[b] P<0.01

[c] P<0.05

Table 3: The effects of neighborhood social deprivation change on psychological distress

	NEIGHBORHOOD IMPROVEMENT[a] VS. CONSTANT HIGH DEPRIVATION				NEIGHBORHOOD WORSENING[a] VS. CONSTANT LOW-MEDIUM DEPRIVATION			
VARIABLES	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 1	MODEL 2	MODEL 3	MODEL 4
Neighborhood change (Ref. no change)	**0.13 (0.01, 0.25)[c]**	**0.13 (0.002, 0.26)[c]**	0.11 (-0.01, 0.23)	0.11 (-0.01, 0.23)	0.05 (-0.06, 0.16)	0.02 (-0.09, 0.14)	0.06 (-0.02, 0.09)	0.07 (-0.04, 0.17)
Age (years)		**-0.01 (-0.02, -0.01)[b]**	**-0.01 (-0.1, -0.002)[b]**	**-0.01 (-0.01, -.002)[b]**		**-0.01 (-0.01, -0.01)[b]**	**-0.01 (-0.01, -0.003)[b]**	**-0.01 (-0.01, -0.003)[b]**
Sex (Ref. Male)		**0.17 (0.05, 0.29)[b]**	0.08 (-0.02, 0.19)	0.09 (-0.02, 0.20)		**0.14 (0.06, 0.21)[c]**	**0.08 (0.01, 0.15)[c]**	**0.08 (0.01, 0.15)[c]**
Marital Status (Ref. married)		0.06 (-0.07, 0.19)	0.09 (-0.02, 0.21)	0.09 (-0.03, 0.21)		0.02 (-0.08, 0.12)	-0.03 (-0.12, 0.06)	-0.03 (-0.12, 0.06)
Race (Ref. Caucasian)		0.15 (-0.14, 0.46)	0.07 (-0.22, 0.36)	0.07 (-0.23, 0.36)		-0.01 (-0.20, 0.19)	-0.07 (-0.25, 0.11)	-0.07 (-0.25, 0.11)
Education (Ref. Post-sec.)								
High school		0.08 (-0.05, 0.21)	0.06 (-0.06, 0.18)	0.06 (-0.06, 0.18)		-0.02 (-0.09, 0.06)	-0.02 (-0.09, 0.06)	-0.02 (-0.09, 0.06)
Less than high school		0.09 (-0.07, 0.25)	0.08 (-0.07, 0.23)	0.07 (-0.08, 0.23)		**0.11 (0.02, 0.22)[b]**	0.09(-0.01, 0.18)	0.08 (-0.01, 0.18)
Income adequacy (Ref. Low)		-0.11 (-0.31, 0.09)	-0.002 (-0.19, 0.19)	-.001 (-0.19, 0.19)		**-0.17 (-0.32, -0.02)[c]**	-0.11 (-0.25, 0.04)	-0.11 (-0.25, 0.04)
Past-year employment (Ref. employed)		**0.19 (0.03, 0.36)[c]**	0.12 (-0.03, 0.27)	0.12 (-0.04, 0.27)		0.09 (-0.02, 0.19)	0.07 (-0.03, 0.17)	0.07 (-0.03, 0.17)
Baseline distress			**0.39 (0.32, 0.46)[b]**	**0.39 (0.32, 0.46)[b]**			**0.39 (0.35, 0.44)[b]**	**0.39 (0.35, 0.44)[b]**
Baseline deprivation (Ref. Low)				0.01 (-0.10, 0.11)				0.01 (-0.06, 0.08)

* Distress scores were log transformed such that (log*(score + 1)).
[a] In the first four models, neighborhood change represents neighborhood improvement (e.g. change from high deprivation to low-medium deprivation), while in the last four models neighborhood change represents neighborhood worsening (e.g. change from low-medium deprivation to high deprivation).
[b] P<0.01
[c] P<0.05

Supplementary Tables

Table A: Baseline demographic characteristics of non-movers in study sample and movers excluded from the study sample

VARIABLES	NON-MOVERS N=2745	MOVERS N=3198	TEST STATISTIC
Age, Mean (SD)	52.79 (13.96)	44.95 (16.49)	P<0.01
Sex, N (%)			
Men	1206 (43.93)	1406 (43.96)	P=0.981
Women	1539 (56.07)	1792 (56.04)	
Marital Status, N (%)			
Married	2029 (73.92)	2247(78.43)	P<0.01
Not Married	716 (26.08)	618 (21.57)	
Race, N(%)			
Caucasian	2644 (96.39)	2958 (92.55)	P<0.01
Non-Caucasian	99 (3.61)	238 (7.45)	
Education, N(%)			
Less than high school	723 (26.39)	733 (22.94)	
High school graduation	1043 (38.07)	1452 (45.45)	P<0.01
Post-secondary education	974 (35.55)	1010 (31.61)	
Income adequacy, N(%)			
Low	250 (9.76)	344 (13.03)	P<0.01
Middle-High	2312 (90.24)	2296 (88.97)	
Past-year Employment, N(%)			
Employed	1788 (70.04)	2083 (79.81)	P<0.01
Not employed	765 (29.96)	527 (20.19)	
Distress, Mean (SD)	0.67 (0.75)	0.88 (0.81)	P<0.01

Table B: The effects of neighborhood material deprivation change on psychological distress, sensitivity analyses

VARIABLES	NEIGHBORHOOD IMPROVEMENT [a] VS. CONSTANT HIGH DEPRIVATION	NEIGHBORHOOD WORSENING [a] VS. CONSTANT LOW DEPRIVATION
Neighborhood change [a] (Ref. no change)	0.08 (-0.03, 0.19)	0.06 (-0.04, 0.15)
Small change (1Quintile change)	-0.06 (-0.26, 0.13)	0.08 (-0.08, 0.24)
Large change (≥2 Quintile change)		
Age (years)	**-0.01 (-0.01, -0.001) [b]**	**-0.01 (-0.01, -0.001) [c]**
Sex (Ref. Male)	0.05 (-0.05, 0.15)	0.08 (-0.01, 0.17)
Marital Status (Ref. married)	-0.01 (-0.13, 0.11)	0.05 (-0.05, 0.16)
Race (Ref. Caucasian)	-0.01 (-0.26, 0.24)	0.01 (-0.19, 0.22)
Education (Ref. Post-sec.)		
High school	-0.03 (-0.14, 0.09)	-0.01 (-0.01, 0.08)
Less than high school	-0.04 (-0.17, 0.08)	**0.25 (0.13, 0.38) [b]**
Income adequacy (Ref. Low)	0.03 (-0.14, 0.20)	-0.02 (-0.13, 0.09)
Past-year employment (Ref. employed)	**0.14 (0.01, 0.27) [c]**	-0.02 (-0.14, 0.09)
Baseline distress	**0.38 (0.32, 0.44) [b]**	**0.44 (0.38, 0.49) [b]**
Baseline deprivation (Ref. Low)	0.07 (-0.03, 0.18)	0.07 (-0.02, 0.16)

[a] Distress scores were log transformed such that (log*(score + 1)).
[b] P<0.01
[c] P<0.05

Table C: The effects of neighborhood social deprivation change on psychological distress, sensitivity analyses

VARIABLES	NEIGHBORHOOD IMPROVEMENT[a] VS. CONSTANT HIGH DEPRIVATION	NEIGHBORHOOD WORSENING[a] VS. CONSTANT LOW DEPRIVATION
Neighborhood change [a] (Ref. no change)		
Small change (1Quintile change)	0.06 (-0.07, 0.19)	0.04 (-0.04, 0.12)
Large change (≥2 Quintile change)	**0.25 (0.03, 0.49)** [c]	-0.04 (-0.24, 0.15)
Age (years)	-0.01 (-0.02, -0.003)	**-0.01 (-0.01, -0.001)** [b]
Sex (Ref. Male)	0.09 (-0.02, 0.22)	**0.09 (0.2, 0.17)** [c]
Marital Status (Ref. married)	0.08 (-0.05, 0.21)	0.003 (-0.09, 0.10)
Race (Ref. Caucasian)	0.001 (-0.29, 0.31)	-0.09 (-0.28, 0.09)
Education (Ref. Post-sec.)		
High school	0.08 (-0.05, 0.20)	-0.05, -0.14, 0.04)
Less than high school	0.07 (-0.09, 0.24)	0.08 (-0.04 (0.16)
Income adequacy (Ref. Low)	-0.01 (-0.21, 0.19)	-0.03 (-0.18, 0.12)
Past-year employment (Ref. employed)	0.15 (-0.01, 0.32)	0.09 (-0.1, 0.19)
Baseline distress	**0.39 (0.31, 0.47)** [b]	**0.39 (0.34, 0.44)** [b]
Baseline deprivation (Ref. Low)	0.01 (-0.10, 0.13)	0.001 (-0.08, 0.08)

[a] Distress scores were log transformed such that (log*(score + 1)).
[b] P<0.01
[c] P<0.05