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The Effect of Collective Efficacy and Neighborhood Structural Disadvantage on Depressive Symptoms among Adolescents in the United States

Christyl Teres Dawson
Florida International University, cdaws011@fiu.edu

FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

THE EFFECT OF COLLECTIVE EFFICACY AND NEIGHBORHOOD STRUCTURAL DISADVANTAGE ON DEPRESSIVE SYMPTOMS AMONG ADOLESCENTS IN THE UNITED STATES

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Christyl Teres Dawson

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To: Dean Tomás R. Guilarte
Robert Stempel College of Public Health and Social Work

This dissertation, written by Christyl Teres Dawson, and entitled The Effect of Collective Efficacy and Neighborhood Structural Disadvantage on Depressive Symptoms among Adolescents in the United States, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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Wensong Wu

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Kristopher P. Fennie

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Gladys Ibañez

_____
Miguel Á. Cano

_____
Jeremy W. Pettit

_____
Mary Jo Trepka, Major Professor

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The dissertation of Christyl Teres Dawson is approved.

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Dean Tomás R. Guilarte
Robert Stempel College of Public Health and Social Work

_____
Andrés G. Gil
Vice President for Research and Economic Development
Dean of the University Graduate School

Florida International University, 2019

DEDICATION

All glory and praise be unto God, who strengthens me. I dedicate this dissertation to my mother and brother. Without their unconditional support, love, and sacrifices, this work would not be possible.

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ABSTRACT OF THE DISSERTATION

THE EFFECT OF COLLECTIVE EFFICACY AND NEIGHBORHOOD STRUCTURAL DISADVANTAGE ON DEPRESSIVE SYMPTOMS AMONG ADOLESCENTS IN THE UNITED STATES

by

Christyl Teres Dawson

Florida International University, 2019

Miami, Florida

Professor Mary Jo Trepka, Major Professor

The purpose of this dissertation was to examine (1) the moderating role of parental neighborhood perceptions on the relationship between neighborhood structural disadvantage and adolescent depressive symptoms, (2) if adolescent neighborhood perceptions moderated the association between neighborhood structural disadvantage and adolescent depressive symptoms, and (3) the effects of neighborhood structural disadvantage on depressive symptom trajectories as well as the moderating role of neighborhood perceptions on the relationship from adolescence to young adulthood. Data came from the National Longitudinal Study of Adolescent to Adult Health (Add Health) (N=12,105), and random effects multilevel modeling along with growth curve modeling were used.

Results showed that parental-perceived neighborhood disorder was significantly associated with higher levels of adolescent depressive symptoms (β=0.27, SE=0.05, $p \leq 0.001$), while adolescent-perceived neighborhood social cohesion (β=0.24, SE=0.04, $p \leq 0.001$) and safety (β=0.47, SE=0.04, $p \leq 0.001$) were significantly associated with lower

depressive symptoms among adolescents after full adjustment. Parental-perceived collective efficacy was not associated with adolescent depressive symptoms ($p>0.05$). Interactions between neighborhood concentrated poverty and parental-perceived neighborhood disorder, adolescent-perceived collective efficacy, contentment, and safety were also significant ($p\leq0.05$). Parental-perceived collective efficacy was not found to be a moderator ($p>0.05$).

Findings suggest that aspects of the neighborhood social environment may help to buffer against depression, particularly in high poverty neighborhoods. Components of neighborhood structural disadvantage and disorder, collective efficacy, contentment, and safety could serve as targets for the development of structural and other intervention strategies such as community-level interventions, aimed at reducing or preventing depression. Ultimately, addressing neighborhood structural disadvantage and improving the social environment may help to reduce depressive symptoms among adolescents as well as depression prevalence and risk, thereby reducing the growing mental health burden among youth.

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INTRODUCTION

Depression among adolescents is a major concern in the United States (U.S.) (U.S. Department of Health and Human Services [DHHS], 2010). Approximately 20–30% of adolescents will experience depression before they become adults, and 10%–15% of adolescents will exhibit some symptoms of depression at any one time (Rushton, Forcier, & Schectman, 2002; U.S. Surgeon General, 1999). Thus, the *Healthy People 2020* goals for the U.S. aim to "reduce the proportion of adolescents aged 12 to 17 years who experience major depressive episodes" and "reduce suicide attempts by adolescents" (U.S. DHHS, n.d.). The DSM-V defines depression as sadness and a loss of interest or pleasure in usual activities for at least two weeks, accompanied by a change in weight or appetite, change in activity (psychomotor agitation or psychomotor retardation), insomnia or sleeping too much, feelings of guilt or worthlessness, difficulty concentrating, fatigue, and thoughts of suicide (American Psychiatric Association [APA], 2013).

In recent years, there has been an increase in the number of adolescents that suffer from depression (Hedden, 2015). It is estimated that the prevalence of depression among those 12 to 17 years old was 12.5% or 3 million in 2015 (Hedden, 2015; National Institute of Mental Health [NIMH], n.d.). This finding was in contrast to a lower estimated prevalence observed in 2004–2012 among those 12–17 years old, that ranged from 7.9%–9.1% (Hedden, 2015). Historically, adolescent girls have been found to have a higher prevalence of depression than adolescent boys. In 2015, adolescent girls had about 3 times the prevalence of depression than adolescent boys (19.5% vs. 5.8%) (NIMH, n.d.). Depression has been found to increase with age during adolescence (NIMH, n.d.). In 2015, the prevalence of depression for adolescents aged 12 was 5.4%

compared to 15% among adolescents aged 17 (NIMH, n.d.). Furthermore, there is variation in the prevalence of depression by race/ethnicity (NIMH, n.d.). Multiracial adolescents have the highest prevalence of depression at 15.6%, followed by Whites (13.4%), Hispanics (12.6%), Asians (9.7%), and Blacks (9.0%) (NIMH, n.d.).

Adolescents who are depressed are at an increased risk of morbidity and mortality compared with adolescents who are not depressed (Thapar, Coolishaw, Pine, & Thapar, 2012). Depressed adolescents are 6–12 times more likely to have an anxiety disorder, 4–11 times more likely to have a disruptive behavior disorder, and 3–6 times more likely to have a substance use disorder (Thapar, Coolishaw, Pine, & Thapar, 2012). In fact, two-thirds of adolescents with depression have at least one comorbid psychiatric disorder, and 10%–15% have 2 or more comorbidities (Thapar, Coolishaw, Pine, & Thapar, 2012). These estimates increase with increased depression severity and predict severe impairment, poor long-term outcomes, and complicate treatment (Centers for Disease Control and Prevention [CDC], 2016; Thapar, Coolishaw, Pine, & Thapar, 2012). Depression also complicates diseases such as eating disorders, autistic spectrum disorders, and attention-deficit/hyperactivity disorder (ADHD) (Thapar, Coolishaw, Pine, & Thapar, 2012). In addition, adolescents who are depressed are at an increased risk of attempting suicide (Office of the Surgeon General & National Action Alliance for Suicide Prevention, 2012). Depression increases an adolescent's risk of attempting suicide by 12 times (Weissman et al., 1999). Suicide is the second leading cause of death for adolescents 10 to 19 years old (Heron, 2016). Suicide death rates increase with increasing age in adolescence (Heron, 2016). Males have a higher suicide rate compared with females (Heron, 2016).

The economic impact of depression can be seen in the direct costs and suicide-related costs to the U.S. healthcare system, which was estimated to be $210.5 billion in 2010 (CDC, 2016). Unfortunately, very few adolescents seek mental health services for treatment due to a lack of access and under-diagnosis (CDC, 2016; Perou et al., 2013). The social consequences of depression include school behavioral problems, poor academic performance, and school absenteeism (CDC, 2016). The effects of depression go beyond adolescents to affect their families, friends, and the community at large (CDC, 2016).

Factors that are associated with increased risk of depression among adolescents have been acknowledged and studied by previous researchers. These risk factors include age (Lewinsohn, Clarke, Seeley, & Rohde, 1994), sex (Jackson & Goodman, 2011; Laukkanen, Hakko, Riipinen, & Riala, 2016; Mendelson, Kubzansky, Datta, & Buka, 2008; Van Voorhees et al., 2008), ethnicity (Van Voorhees et al., 2008), race (Van Voorhees et al., 2008), educational level (Korhonen, Remes, & Martikainen, 2017), family socioeconomic status (Jackson & Goodman, 2011; Mendelson, Kubzansky, Datta, & Buka, 2008; Najman et al., 2010; Van Voorhees et al., 2008), family structure (Hayatbakhsh, 2010; Laukkanen, Hakko, Riipinen, & Riala, 2016), and neighborhood perceptions (Ford & Rechel, 2012; Goldman-Mellor, Margerison-Zilko, Allen, & Cerdá, 2016; Nalls, Mullis, & Mullis, 2009). It has been found that girls and ethnic/racial minorities are at increased risk of depression due to increased societal pressures and discrimination (Jackson & Goodman, 2011; Laukkanen, Hakko, Riipinen, & Riala, 2016; Mendelson, Kubzansky, Datta, & Buka, 2008; Van Voorhees et al., 2008). In addition, living with both biological parents has been associated with lowered risk of depression,

while living with only one biological parent or living with a parent who is divorced is associated with increased risk of depression due to increased familial conflict and lowered family functioning (Hayatbakhsh, 2010; Laukkanen, Hakko, Riipinen, & Riala, 2016). Moreover, being of a lower socioeconomic status has been found to be associated with increased depression among adolescents due to the stress and economic hardships growing up in poverty causes (Jackson & Goodman, 2011; Mendelson, Kubzansky, Datta, & Buka, 2008; Najman et al., 2010; Van Voorhees et al., 2008). Similarly, among adolescents, perceptions of living in an unsafe neighborhood and being unsatisfied with their neighborhood have been found to be associated with increased depressive symptoms due to stress (Ford & Rechel, 2012; Goldman-Mellor, Margerison-Zilko, Allen, & Cerdá, 2016; Nalls, Mullis, & Mullis, 2009).

In recent years, research has begun to focus on how the environment of neighborhoods influences depression (Araya et al., 2006; Ahern & Galea, 201l; Bassett & Moore, 2013; Brissen et al., 2013; Daoud et al., 2016; Echeverría et al., 2008; Fullerton et al., 2015; Giurgescu et al., 2015; Hamano et al., 2010; Hurd et al., 2013; Kim, 2010; Kingsbury et al., 2015; Kling, Liebman, & Katz, 2007; Leventhal & Brooks-Gunn, 2003; Maimon et al., 2010; Ross, 2000; Rudolph, Stuart, Glass, & Merikangas, 2014; Silver, Mulvey, & Swanson, 2002; Simons et al., 2002; Stafford et al., 2011; Vaeth et al., 2015; Xue, Leventhal, Brooks-Gunn, & Earls, 2005). Aspects of the neighborhood environment that have been increasingly studied are components of the neighborhood social environment such as collective efficacy, neighborhood disorder, safety, and neighborhood structural disadvantage. *Collective efficacy* refers to the "willingness of neighborhood residents to come together and to take action for the common good"

(Sampson, Raudenbush, & Earls, 1997). It consists of informal social control, which is the "ability of residents to induce public order and obtain resources for the community", and social cohesion, which involves "neighbors knowing, helping, and trusting each other" (Sampson, Raudenbush, & Earls, 1997). *Neighborhood disorder* may be defined as observed or perceived physical and social features of neighborhoods such as people drinking or taking drugs on the streets, conflict and fighting, gang activity, street prostitution, abandoned housing, graffiti, and litter in the streets (Gracia, 2014). *Neighborhood structural disadvantage* refers to the lack of institutional, social and material resources needed to build solidarity (Hill & Maimon, 2013).

Collective efficacy, neighborhood disorder, and safety have been found to be associated with depression among adolescents (Ahern & Galea, 2011; Brissen et al., 2013; Drukker et al., 2004; Echeverría et al., 2008; Fullerton et al., 2015; Hurd et al., 2013; Kingsbury et al., 2015; Maimon et al., 2010; Stafford et al., 2011; Vaeth et al., 2015; Xue, Leventhal, Brooks-Gunn, & Earls, 2005). Among a sample of urban Midwestern African-American adolescents, higher levels of social cohesion were correlated with lower levels of depressive symptoms (Hurd, Stoddard, & Zimmerman, 2013). Additionally, in a cross-sectional study conducted among a national sample of U.S. adolescents aged 12–17 years, perceptions of neighborhood disorder and lack of social cohesion were associated with higher odds of adolescent depression diagnosis and adolescent depressive symptoms (Ford & Rechel, 2012). In a sample of Black youth, those who perceived their neighborhoods as unsafe had higher odds of major depressive disorder (Assari, & Caldwell, 2017) and a study conducted in California found that adolescents who perceived their neighborhoods as unsafe were two times more likely

than those who perceived their neighborhoods as safe to report serious psychological distress (Goldman-Mellor, Margerison-Zilko, Allen, & Cerda, 2016).

Likewise, neighborhood structural disadvantage has been found to be associated with rates of major depression, depressive symptoms, and depression severity (Kim, 2010; Kling, Liebman, & Katz, 2007; Leventhal & Brooks-Gunn, 2003; Ross, 2000; Silver, Mulvey, & Swanson, 2002; Simons et al., 2002; Xue, Leventhal, Brooks-Gunn, & Earls, 2005). Specifically, neighborhood structural disadvantage has been found to directly increase depression over time (Kim, 2010). Also, neighborhood structural disadvantage has been found to be associated with higher rates of major depressive disorder (Silver, Mulvey, & Swanson, 2002). In addition, neighborhood structural disadvantage has been found to be associated with higher levels of depression severity (Ross, 2000; Xue, Leventhal, Brooks-Gunn, & Earls, 2005). Residential mobility has been found to be associated with higher rates of major depression (Silver, Mulvey, & Swanson, 2002). Neighborhood poverty has been found to be associated with higher depressive symptoms among African-American children (Simons et al., 2002). However, findings on the association between neighborhood structural disadvantage and depression have been mixed (Gonzales et al., 2010; Rudolph, Stuart, Glass, & Merikangas, 2013). This has been reportedly attributed to fact that internalizing symptoms such as depression are not exhibited until later adolescence (Gonzales et al., 2010; Lewinsohn, Clarke, Seeley, & Rohde, 1994; Rudolph, Stuart, Glass, & Merikangas, 2013).

The overall objective of this dissertation was to examine the associations between neighborhood structural disadvantage as well as each of its components (i.e. concentrated poverty, residential instability, and immigrant concentration) and depressive symptoms

among a diverse, nationally representative sample of adolescents in the U.S. Additionally, we sought to examine the moderating role of parental and adolescent perceptions of the neighborhood social environment (i.e. collective efficacy, safety, contentment, and disorder) on the this relationship from adolescence to young adulthood. These objectives were accomplished through three studies. The first study aimed to (1) examine the moderating role of parental neighborhood perceptions on the relationship between neighborhood structural disadvantage and adolescent depressive symptoms. The second study aimed to (2) examine if adolescent perceptions of neighborhood social cohesion and safety moderated the association between neighborhood structural disadvantage and adolescent depressive symptoms. Lastly, the third study aimed to (3) investigate the effects of neighborhood structural disadvantage on depressive symptom trajectories as well as the moderating role of neighborhood perceptions on the relationship during adolescence and young adulthood.

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MANUSCRIPT 1

Parental-perceived neighborhood characteristics and adolescent depressive symptoms: A multilevel moderation analysis

Abstract

Aims: This study examines the moderating role of parental neighborhood perceptions on the relationship between neighborhood structural disadvantage and adolescent depressive symptoms. **Methods:** Data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) consisting of 12,105 adolescents and their parents were used. **Results:** Mixed effects multilevel modeling revealed that parental-perceived neighborhood disorder was associated with higher levels of adolescent depressive symptoms ($\beta=0.27$, $p\leq0.001$). The interaction between neighborhood concentrated poverty and parental-perceived neighborhood disorder was also significant ($\beta=-0.14$, $p\leq0.01$). Low and high levels of parental-perceived neighborhood disorder were associated with lower ($\beta=-0.41$, $p<0.05$) and higher ($\beta=0.46$, $p\leq0.01$) levels of adolescent depressive symptoms, respectively, with increasing concentrated poverty. Parental-perceived collective efficacy was not associated with adolescent depressive symptoms nor was it a moderator. **Conclusion:** Findings suggest that the neighborhood's social environment may mitigate adolescent depressive symptoms. Implications for structural interventions are discussed.

Keywords: Neighborhood structural disadvantage; adolescents; depressive symptoms; collective efficacy; neighborhood disorder; neighborhood social environment; National Longitudinal Study of Adolescent to Adult Health

Introduction

Depression is common among adolescents in the United States (U.S.) (Mojtabai, Olfson, & Han, 2016). Past-year prevalence of depression among adolescents aged 12–17 was 12.8% in 2016, and it is estimated that approximately 20% of adolescents will have a depressive disorder by the time they reach adulthood (National Institute of Mental Health, 2017; Thapar, Collishaw, Pine, & Thapar, 2012). This represents a public health issue as adolescents who are depressed experience substantial impairment in functioning and have an increased risk of comorbid psychiatric disorders such as suicide and substance abuse compared to adolescents that are not depressed (Thapar, Collishaw, Pine, & Thapar, 2012; U.S. Department of Health and Human Services, 2010). Further, depression puts tremendous strain on the healthcare system. In 2010 in the U.S., it was estimated that depression was responsible for $210.5 billion dollars in direct and suicide-related costs (Centers for Disease Control and Prevention, 2016).

Much of the research on depression among adolescents has focused on individual-level predictors and correlates of depression (Cairns, Yap, Pilkington, & Jorm, 2014). However, in recent years, research has begun to focus on how the environment of neighborhoods influences depression among this population (Gonzales et al., 2011; Hurd, Stoddard, & Zimmerman, 2013; Kingsbury et al., 2015; Kling, Liebman, & Katz, 2007, Lee & Liechty, 2015; Leventhal & Brooks-Gunn, 2003; Maimon, Browning, & Brooks-Gunn, 2010; Rudolph, Stuart, Glass, & Merikangas, 2014; Simons et al., 2002; Snedker & Herting, 2016; Xue, Leventhal, Brooks-Gunn, & Earls, 2005). Aspects of the neighborhood environment that have been increasingly studied are collective efficacy, neighborhood disorder, and neighborhood structural disadvantage.

Rooted in social disorganization theory by the work of Shaw and McKay in 1969, *collective efficacy* is defined as the willingness of neighborhood residents to come together and to take action for the common good (Bellair, 2017; Sampson, Raudenbush, & Earls, 1997). It consists of *informal social control*, which is the "ability of residents to induce public order and obtain resources for the community", and *social cohesion*, which involves "neighbors knowing, helping, and trusting each other" (Sampson, Raudenbush, & Earls, 1997). *Neighborhood disorder* is defined as observed or perceived physical and social features of neighborhoods such as people drinking or taking drugs on the streets, conflict and fighting, gang activity, street prostitution, abandoned housing, graffiti, and litter in the streets (Gracia, 2014; Sampson, Raudenbush, & Earls, 1997). These features may indicate the dissolution of order and social control within a community, which can erode the quality of life for residents residing in that neighborhood (Gracia, 2014). *Neighborhood structural disadvantage* refers to the lack of institutional, social and material resources needed to build solidarity (Hill & Maimon, 2013). It has been measured by Browning, Burrington, Leventhal, and Brooks-Gunn with three measures: concentrated poverty, which is the level of socio-economic deprivation; residential instability, which is the movement of individuals in and out of neighborhoods; and immigrant concentration, which is the proportion of foreign-born residents (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008; Browning & Cagney, 2002).

Living in neighborhoods with higher levels of structural disadvantage has been shown to adversely affect mental health (Hill & Maimon, 2013). In a randomized-controlled trial, boys 8–13 years old who moved from public housing in high-poverty neighborhoods to private housing in low-poverty neighborhoods had a 25% significant

reduction in reported depressive and dependency problems compared to boys who did not move (Leventhal & Brooks-Gunn, 2003). In addition, in a sample of Latino youth in the U.S., participants who lived in neighborhoods with greater poverty had higher odds of depression (Lee & Liechty, 2015). Moreover, for children aged 5–11 years in Chicago, more mental health problems were seen for those living in neighborhoods with high concentrated poverty (Xue, Leventhal, Brooks-Gunn, & Earls, 2005). However, in a study conducted among African-American children aged 10–12 years living in Iowa and Georgia, neighborhood poverty was not correlated with depressive symptoms (Simons et al., 2002). Likewise, a study of Mexican-American adolescents in a large southwest metropolitan area of the U.S. found that neighborhood disadvantage was not directly associated with adolescent mental health (Gonzales, 2011).

Moreover, research has shown that parental concerns about the neighborhood environment can have an impact on adolescent behaviors (Kepper et al., 2016; Kimbro & Schachter, 2011). Parents may restrict adolescents' interactions in neighborhoods that they view negatively, thereby increasing adolescents' social isolation (Ford & Rechel, 2012). Specifically, parental perceptions of collective efficacy and disorder of the neighborhood environment have been found to influence adolescent mental health. In a cross-sectional study conducted among a national sample of U.S. adolescents aged 12–17 years, parental perceptions of neighborhood disorder and lack of social cohesion were associated with higher odds of adolescent depression diagnosis and adolescent depressive symptoms (Ford & Rechel, 2012). Also, in a cross-sectional study examining the association between parental perceived collective efficacy and depression among children, higher levels of parental perceived collective efficacy were associated with

fewer experiences of depressive symptoms (Donnelly et al., 2016). Similar findings have been reported in longitudinal studies (Kingsbury et al., 2015; Solmi, Colman, Weeks, Lewis, & Kirkbride, 2017). A longitudinal study conducted in the United Kingdom found that low levels of parental perceptions of neighborhood cohesion predicted higher odds of depression among 18-year-old adolescents (Solmi, Colman, Weeks, Lewis, & Kirkbride, 2017). In addition, a longitudinal study conducted among children in Canada found that compared to those living in stable moderately socially cohesive neighborhoods, those in stable low socially cohesive neighborhoods were more likely to experience depressive symptoms (Kingsbury et al., 2015).

Current study

The current study attempts to address gaps in the literature by elucidating possible moderators that influence depressive symptoms among adolescents, which may be particularly susceptible to the influences of the neighborhood environment. The relationship between neighborhood structural disadvantage and depression is still poorly understood, and findings have been inconsistent, especially among adolescents (Blair, Ross, Gariepy, & Schmitz, 2014). Previous research has been limited by small sample sizes, geographically restrictions, and a lack of racial/ethnic diversity (Gonzales, 2011; Lee & Liechty, 2015; Leventhal & Brooks-Gunn, 2003; Simons et al., 2002; Xue, Leventhal, Brooks-Gunn, & Earls, 2005). Potential buffering effects of the social environment in disadvantaged neighborhoods have been understudied, especially in the context of parental perceptions of the neighborhood.

We test an adapted theoretical framework that could help to guide future research in the study of the influence of neighborhood structural disadvantage and

adolescent depressive symptoms. Our study was guided by the Ecological Systems Theory of Human Development, which posits that child development is influenced by the interaction between the individual and his/her environment (Bronfenbrenner, 1994). According to this theory, the environment can be divided into various subsystems including the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. For the purposes of the current study, only the exosystem, which consists of the neighborhood-community context, was examined. The exosystem contains events that influence processes within the immediate environment in which a developing person lives. These processes can influence the psychological development of an adolescent in a positive or negative way, thereby impacting mental health. The theoretical framework by Hill and Maimon (2013), which helps to elucidate the relationship between the neighborhood environment and depression, was also used in the conceptualization of the current study. The framework shows how neighborhood structural disadvantage may have an influence on depression. However, the strength of this influence is moderated by an individual's perception of neighborhood collective efficacy. We integrated these two theoretical perspectives to develop an adapted theoretical framework that focuses on adolescents (see Figure 1). No study, to our knowledge, has examined whether parental neighborhood perceptions mitigate adolescent depressive symptoms in disadvantaged neighborhoods using such a theoretical framework.

Therefore, our study's aim was to examine the moderating roles of parental-perceived collective efficacy and parental-perceived neighborhood disorder on the relationship between neighborhood structural disadvantage and depressive symptoms

among adolescents in the U.S. Based on our adapted theoretical framework and previous research, we hypothesized the following:

1) Parental-perceived collective efficacy attenuates the relationship between neighborhood structural disadvantage and levels of depressive symptoms in adolescents.

2) Parental-perceived neighborhood disorder strengthens the relationship between neighborhood structural disadvantage and levels of depressive symptoms in adolescents. In addition, as an exploratory analysis, potential gender differences were examined given the well-documented higher prevalence of depression among females than males. It is possible that differential neighborhood effects between female and male adolescents contribute to gender differences in the prevalence of depression (Mojtabai, Olfson, & Han, 2016).

Methods

Study design

Data from the 1994–1995 National Longitudinal Study of Adolescent to Adult Health (Add Health) core sample (N=12,105) were used to assess the moderating roles of parental-perceived collective efficacy and parental-perceived neighborhood disorder on the association between neighborhood structural disadvantage and depressive symptoms among adolescents (Harris, 2009). Add Health is a nationally representative school-based study, designed to determine the developmental trajectories of adolescents into adulthood (Harris, 2011; Harris, 2013). Schools were sampled based on region, urbanicity, size, type, and ethnicity composition of the target population. For a school to be eligible, it had to include the 11th grade and have more than 30 students enrolled. For the in-home core sample students were stratified by grade and sex. About 17 students were randomly

chosen from each stratum so that about 200 adolescents were selected from each of the 80 pairs of schools. Due to how the in-home core sample was chosen, the sample is self-weighting and nationally representative (Chen & Chantala, 2014). Data were collected with an in-home questionnaire at the respondent's home using computer-assisted personal interviewing (CAPI) and computer-assisted self-interviewing (CASI). Parents of the core sample were asked to complete a parent questionnaire. The mother or other female head of household was the preferred respondent because previous studies have shown that mothers are more aware than fathers of their child's schooling, health behaviors, and health status. Interviews took 1 to 2 hours to complete (Carolina Population Center, n.d.). A detailed description of the Add Health methodology can be found elsewhere (Harris, 2011; Harris, 2013).

Measures

Depressive symptoms. Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale (CES-D). In the Add Health study, a modified 19-item version of the original 20-item CES-D scale was used. The item omitted was "I had crying spells." The modified version of the scale has beenvalidated and has been found to be highly reliable (Jacobson & Rowe, 1999; Wight, Botticello, & Aneshensel, 2006). A sample item is: "You were bothered by things that don't usually bother you." For each item, respondents had to choose how often each statement was true in the past week. Respondents could choose "never or rarely," "sometimes," "a lot of the time," "most of the time or all of the time." To obtain a depressive symptom score, items were summed while taking into consideration reverse coding. The depressive symptom score was treated as a continuous variable. Each item was considered a depressive symptom,

and higher scores indicated higher levels of depressive symptoms. Cronbach's alpha in this sample was 0.88.

Neighborhood structural disadvantage. Neighborhood structural disadvantage consisted of the following components: concentrated poverty, residential instability, and immigrant concentration (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008; Browning & Cagney, 2002). Each component was assessed at the census tract level taken from the Add Health Contextual I dataset. Neighborhoods were defined as census tracts. Scores for each construct of neighborhood structural disadvantage were obtained by conducting a principal component analysis. The first component was concentrated poverty, which consisted of percent receiving public assistance, percent unemployed, percent female-headed households, and percent living below the poverty line. The second component was residential instability, which consisted of percent living in the same house since 1985 and percent houses occupied by owners. The third component was immigrant concentration, which was the percent Latino/Hispanic and percent foreign-born. Cronbach's alpha for the entire index was relatively low (0.55); thus, we separated the neighborhood structural disadvantage index into components (Tavakol & Dennick, 2011). Factor loadings obtained for each principal component were used as weights to arrive at a score for each census tract (or neighborhood). Factor loadings for each component are presented in Appendix A. Because the factor loadings met Thurstone's (1947) criteria for accurate interpretation, no rotation was used. All values were standardized with a mean of zero and a standard deviation of one prior to conducting principal component analysis due to differences in units of measurement (Ringnér, 2008).

Scores were ranked into quartiles so that the first quartile (Quartile 1) represented the least disadvantaged neighborhoods to faciliate interpretation.

Parental-perceived neighborhood informal social control. Parental-perceived neighborhood collective efficacy as measured by informal social control was assessed by the following 2 items: "If a neighbor saw your child getting into trouble, would your neighbor tell you about it?" and "If you saw a neighbor's child getting into trouble, would you tell your neighbor about it?" Items were summed while taking into consideration reverse coding with higher scores indicating higher levels of informal social control. The items were found to have moderate internal consistency (Cronbach's alpha=0.59).

Parental-perceived neighborhood disorder. Parental-perceived neighborhood disorder was assessed by the following 3 items: "How much would you like to move away from this neighborhood?" "In this neighborhood, how big a problem are drug dealers and drug users?" and "In this neighborhood, how big a problem is litter or trash on the streets and sidewalks?" The items were summed with higher scores indicating higher parental perceived neighborhood disorder. The measure had an adequate internal consistency (Cronbach's alpha=0.66).

Covariates. Confounding variables assessed included age, gender, race/ethnicity, family structure, family income, parent occupation, and parent education. Age was assessed as a continuous measure reported by the adolescent. Gender was assessed as the participants' sex assigned at birth, coded as 0=male and 1=female. Race/ethnicity was assessed as a categorical variable and coded as 1=non-Hispanic white, 2=Hispanic, and 3=other non-Hispanic. Family structure was assessed as a categorical variable coded as 0=two-parent, 1=one-parent, and 2=other structured household. Family income was

reported by the parent as the total amount of income, before taxes, the family received in 1994 and was assessed as a continuous variable. Parent occupation was assessed as a categorical variable reported by the adolescent for each parent and was coded as 1=professional/managerial, 2=other professional, which included community/social services, education/training/library, and arts/design/entertainment/sports/media occupations; 3=sales, service, and administration; 4=manual/blue collar, 5=other (unspecified), and 6=not working. The highest status occupation from either parent was used. The status of occupations was based on the U.S. Census Bureau classifications and rankings used in previous Add Health studies (Lui, Chung, Ford, Grella, & Mulia, 2015; Lui, Chung, Wallace, & Aneshensel, 2014), and the highest status occupation was professional/managerial. Parent education was taken as a categorical variable reported by the adolescent. It was coded as 0=a college graduate, 1=some college, 2=high school graduate, and 3=less than high school. The highest educational level for either parent was used as the value for the variable.

Statistical analysis

Descriptive statistics included medians and interquartile ranges for continuous variables due to the data being non-normally distributed as well as counts and percentages for categorical variables. Variables that were found to be non-normally distributed were age, family income, the depressive symptom score, parental-perceived collective efficacy, and parental-perceived neighborhood disorder. The skewness values of the residuals were -0.04, 8.91, 1.13, -0.90, and 0.91 for age, family income, the depressive symptom score, parental-perceived collective efficacy, and parental-perceived neighborhood disorder, respectively. The values indicated that the distributions for age

and parental-perceived collective efficacy were skewed to the left, while the distributions for family income, the depressive symptom score, and parental-perceived neighborhood disorder were skewed to the right. Means and standard deviations are included for the continuous variables as well for comparison.

Bivariate analyses were conducted to determine the association between neighborhood structural disadvantage components (i.e. concentrated poverty, residential instability, and immigrant concentration), parental neighborhood perceptions, and adolescent depressive symptoms. Non-parametric tests Spearman's rho, for continuous variables, and Kruskal-Wallis, for categorical independent variables, were performed. In addition, parametric tests Pearson's rho for continuous variables and ANOVA for categorical independent variables were conducted for comparison. Correlations, chi-square, and F statistics with respective p-values are reported. The Hommel correction was applied to the p-values to adjust for multiple hypothesis testing (Blakesley et al., 2009).

Multilevel mixed models were fitted in stages to evaluate individual- and neighborhood-level characteristics associated with adolescent depressive symptoms. Data were not transformed prior to modeling since normality tests are generally conservative (Razali & Wah, 2011). The modeling performed is considered robust enough to withstand a certain amount of deviations of assumptions (Bell, Fairbrother, & Jones, 2018). The first model was the empty model, which included only census tract and the dependent variable depressive symptom score. From this model the intraclass correlation (ICC) was calculated to be 0.03; although low, it is typical for population-based studies (Killip, Mahfoud, & Pearce, 2004). The design effect was of 1.17 and 1.03, for the mean and the median number of participants in a census tract, respectively. The mean and median were

used to calculate the design effect due to the high number of census tracts with only 1 participant. Although the design effects were small, we were interested in level-2 as well as level-1 effects. Therefore, a multilevel model was considered appropriate for the study to control for the neighborhood environment in order to obtain unbiased estimates (Killip, Mahfoud, & Pearce, 2004; Lai & Kwok, 2015). Next, individual-level characteristics, including parental neighborhood perceptions were added to the model. Both parental neighborhood perceptions were included in the models because the correlation, although statistically significant, was low (Pearson's rho coefficient= -0.04, p-value $\leq$0.001). Finally, neighborhood structural disadvantage variables were added.

To determine whether parental perceptions of neighborhood collective efficacy and disorder moderated the relationship between neighborhood structural disadvantage and adolescent depressive symptoms, the following interactions were included: *parental-perceived collective efficacy x concentrated poverty*, *parental-perceived collective efficacy x residential instability*, *parental-perceived collective efficacy x immigrant concentration*, *parental-perceived neighborhood disorder x concentrated poverty*, *parental-perceived neighborhood disorder x residential instability*, and *parental-perceived neighborhood disorder x immigrant concentration*. We examined the interactions for parental-perceived collective efficacy and parental-perceived neighborhood disorder in separate models. In addition, gender differences were examined by adding 3-way interaction terms to the models. For any significant interactions, conditional beta estimates were calculated using the fully adjusted model with the mean (SD) and graphs were plotted for ease of interpretation. Conditional beta estimates were also calcuated using the median (IQR) and graphs plotted for comparison.

Multiple imputation was used to handle missing data. The MI procedure was used to perform imputation, and the MIANALYZE procedure was used for pooling the estimates in SAS. Imputation methods used were linear regression and the discriminant function for continuous and categorical variables, respectively (Yuan, 2010). Twenty-five imputed datasets were created, following White, Royston, and Wood's (2011) recommendation that the number of imputed datasets should equal the percentage of incomplete cases. The highest percentage of incomplete cases for a variable was for family income (percentage of incomplete cases was 24.16%, which was rounded up to the nearest whole number to obtain the number of datasets to be imputed). All variables used in the analysis model were used in the imputation model, including all interaction terms except for the neighborhood classification variable, to obtain adequate results (He, 2010). Analyses were conducted using SAS v9.4 statistical software (SAS Institute, 2013).

Results

Descriptive characteristics of the study sample

The individual- and neighborhood-level characteristics of the study sample are presented in Table 1. The mean age was 15.5 [median=16.0] years [standard deviation (SD)= 1.8, interquartile range (IQR)=3.0]. The majority of the participants were non-Hispanic white (61.4%), female (52.3%), and came from a two-parent family household (64.9%). The mean parental-perceived collective efficacy score was 8.2 (SD=1.6, median=8.0, IQR=3.0). The mean parental-perceived neighborhood disorder score was 4.6 (SD=1.5, median=4.0, IQR=2.0). Adolescent depressive symptom scores were in the

mild range (mean=11.0, SD=7.6, median=10.0, IQR=10.0), falling below the commonly used clinical cut off score of 16.

Bivariate associations between sample characteristics and adolescent depressive symptoms

Table 2 shows the bivariate analyses between variables of interest. No differences in statistical significance were found between the parametric and non-parametric tests. Adolescent depressive symptom scores were significantly associated with all neighborhood-level variables (p-value ≤0.01) and parental-perceived neighborhood disorder (p-value ≤0.001), but not parental-perceived neighborhood collective efficacy (parametric test p-value=0.93, non-parametric test p-value=0.81). All other individual-level characteristics were significantly associated with adolescent depressive symptoms (p-value ≤0.01; see Appendix B). Parental-perceived neighborhood disorder was significantly associated with all neighborhood-level variables (p-value ≤0.001; see Appendix C), except residential instability (parametric test p-value=0.08, non-parametric test p-value=0.17; see Appendix C). Similarly, parental-perceived neighborhood collective efficacy was significantly associated with all neighborhood-level variables (p-value ≤0.001; see Appendix C), except residential instability (parametric test p-value=0.93, non-parametric test p-value=0.81; see Appendix C).

Multilevel modeling of adolescent depressive symptoms

Table 3 shows the adjusted multilevel models. In Model 1, which had no interaction terms, individual-level variables that were significantly associated with higher levels of adolescent depressive symptoms were age (β=0.36, SE=0.04, Cohen's f=0.007), being female (β=1.75, SE=0.13, Cohen's f=0.015) compared to being male, being

Hispanic (β=0.87, SE=0.26, Cohen's f=0.002002) or non-Hispanic other (β=1.01, SE=0.18, Cohen's f=0.002) compared to being non-Hispanic White, having a parent with a high school education (β=1.18, SE=0.18, Cohen's f=0.013) or less than a high school education (β=2.70, SE=0.25, Cohen's f=-0.013) compared to having a parent that was a college graduate, having a parent employed in a manual/blue collar occupation (β=0.82, SE=0.28, Cohen's f=0.010) or other (unspecified) occupation (β=0.51, SE=0.23, Cohen's f=0.001) compared to having a parent in a professional/managerial occupation, and living in a household with one parent (β=0.82, SE=0.17, Cohen's f=0.004) or other type of family structured household (β=1.54, SE=0.31, Cohen's f=0.004) compared to living in a two-parent household. In addition, parental-perceived neighborhood disorder was significantly associated with adolescent depressive symptoms (p-value ≤0.001; Cohen's f=0.003). Every unit increase in parental-perceived neighborhood disorder was associated with a 0.27 unit increase adolescent depressive symptom scores. None of the neighborhood-level variables or parental-perceived collective efficacy were significantly associated with adolescent depressive symptom scores.

Multilevel models containing interaction terms are displayed in Table 3 in Model 2 and Model 3. All associations remained significant as in Model 1. None of the interaction terms with parental-perceived collective efficacy were significant. However, the interaction between concentrated poverty and parental-perceived neighborhood disorder was significant (p-value ≤0.01; Cohen's f=0.002). The conditional estimates by parental-perceived neighborhood disorder at the mean-2SD, mean, and mean+2SD are displayed in Figure 2a along with a graphical representation of this interaction.

The graph shows that at mid (mean) (β=0.03, SE=0.08) and higher (mean+2SD) (β=0.46, SE=0.16) levels of parental-perceived neighborhood disorder, higher concentrated poverty levels were associated with higher adolescent depressive symptom scores as depicted by the slopes and conditional estimates. However, only the slope for parental-perceived neighborhood disorder at higher (mean+2SD) levels was statistically significant ($p \leq 0.01$). In contrast, at the lowest (mean-2SD) levels of parental-perceived neighborhood disorder, concentrated poverty was associated with lower levels of adolescent depressive symptoms. The findings indicate that lower levels of parental-perceived neighborhood disorder moderated the effect of poverty on depressive symptoms. Similar results were obtained using the median and IQR (see Figure 2b). Models that tested the 3-way interaction terms with gender were found to not be significant as shown in Appendix D. This indicates that gender did not significantly moderate the associations between neighborhood structural disadvantage, parental-perceived neighborhood perceptions, and adolescent depressive symptoms.

Discussion

In the current study, we found that in addition to individual-level factors, higher concentrated poverty and higher parental perceptions of neighborhood disorder were associated with higher adolescent depressive symptoms. Importantly, family income was not associated with adolescent depressive symptoms although low levels of parental education and parental manual/blue collar employment were associated with adolescent depressive symptoms. Specifically, adolescents who lived in neighborhoods with high levels of concentrated poverty had higher levels of depressive symptoms, independent of family income. Moreover, the association between concentrated poverty and adolescent

depressive symptoms depended on parental perceptions of neighborhood disorder. Higher levels of parental-perceived neighborhood disorder were associated with higher levels of adolescent depressive symptoms, while lower levels of parental-perceptions of neighborhood disorder were associated with lower levels of adolescent depressive symptoms across all levels of concentrated poverty. In addition, the relative increase and decrease was most pronounced among adolescents living in the highest poverty neighborhoods. No gender differences were found when testing the 3-way interactions. Furthermore, parental-perceived collective efficacy was not found to be associated with depressive symptoms; nor was it a moderator of the association between depressive symptoms and any component of neighborhood structural disadvantage. Thus, our hypotheses were partially supported. Our null findings with respect to collective efficacy may have been due to our inability to adequately measure parental-perceived collective efficacy as indicated by a moderate Cronbach's alpha for the scale. Also, it may be that parental-perceived collective efficacy operates as a mediator rather than a moderator of the relationship between neighborhood structural disadvantage and adolescent depressive symptoms. Research has shown that individual perceptions of the neighborhood environment when added to models can attenuate the association between neighborhood SES and depressive symptoms (Kim, 2008).

Our study extends the understanding of how the neighborhood environment may influence adolescent depression. First, this study suggests that family income may not be as relevant as concentrated poverty to adolescent depressive symptoms because family income was not associated with adolescent depressive symptoms in any of the models. Albeit, family income was associated with adolescent depressive symptoms in the

bivariate analysis. It may be that family income was not significant in the models due to the presence of the parental education and occupation variables in the model. Findings from studies abouton the relationship between family income and adolescent depression have been mixed. Studies suggest that family income is associated with depression among children and adolescents, but associations have been found to be weak and relevant only for adolescents with the lowest levels of family income (Melchior et al., 2010; Najman et al., 2010; Reiss, 2013). Among a representative sample of adolescents in Seattle, Washington, family annual income was only found to be significantly associated with adolescent depressive symptoms for those with low family income after controlling for life events within the past 6 months and no longer significant after adjusting for family environment (Tracy, Zimmerman, Galea, McCauley, & Vander Stoep, 2008). In a longitudinal study conducted across the U.S. on children 0–18 years old, family poverty at any period of development was not associated with increased odds of internalizing index scores or depression after controlling for all covariates (Björkenstam, Pebley, Burström, & Kosidou, 2017). This is consistent with our finding that family income does not have as much bearing on depressive symptoms among adolescents as neighborhood poverty, especially if the adolescent lives in a poor neighborhood. Other aspects of family socioeconomic status, specifically parent education and parent occupation, were found to be associated with higher levels ofadolescent depressive symptoms in our study sample.

Second, and relatedly, concentrated poverty was the only aspect of neighborhood structural disadvantage found to be significantly associated with adolescent depressive symptoms in our study. The association between neighborhood poverty and adolescent

mental health has also been found in other studies. A housing mobility intervention, Moving to Opportunity, conducted among families in Baltimore, Boston, Chicago, Los Angeles, and New York showed that boys residing in poor neighborhoods had increased risk of depressive symptoms (Kessler et al., 2014). In addition, a longitudinal study conducted in Canada found that living in poor neighborhoods predicted suicidal thoughts and attempts in late adolescence (Dupéré, Leventhal, & Lacourse, 2009). Our finding of residential instability and immigrant concentration not being associated with adolescent depression is supported by several other studies that found no association between these aspects of neighborhood structural disadvantage and adolescent mental health (Gilman, Kawachi, Fitzmaurice, & Buka, 2003; Lewis et al., 2015; Maimon, Browning, & Brooks-Gunn, 2010). This may mean that these aspects of the neighorhood structural enviroment do not have as much bearing on adolescent mental health as concentrated poverty.

Third, in our study parental perceptions of the neighborhood arewere associated with adolescent depression, specifically parental perceptions of neighborhood disorder, which is in line with other studies (Ford & Rechel, 2012; Solmi, Colman, Weeks, Lewis, & Kirkbride, 2017). Parental perceptions of the neighborhood may be a true indication of the neighborhood environment and reflect the environment to which the adolescents are exposed. Alternatively, they may reflect parent's own mental health or behaviors. Our results, which do not assess parental functioning, nevertheless parallel findings ofstudies which report increased neighborhood disorder is associated with lowered family functioning through harsh parenting and lack of parental warmth, thereby increasing adolescent depressive symptoms (Barajas-Gonzalez & Brooks-Gunn, 2014; Jocson & McLoyd, 2015). Parental perceptions of the neighborhood have linked to effective

parenting behaviors (Barajas-Gonzalez & Brooks-Gunn, 2014; Byrnes & Miller, 2012). Moreover, neighborhood disorder was significantly associated with harsh parenting styles among a sample of Mexican and African-American families (Barajas-Gonzalez & Brooks-Gunn, 2014). We did not find that parental perceptions of neighborhood collective efficacy were associated with adolescent depressive symptoms, which may have been due to our inabilitity to sufficiently measure the construct. This is in contrast to other studies, which have found a significant relationship between neighborhood collective efficacy and adolescent mental health (Ford & Rechel, 2012; Kingsbury et al., 2015; Maimon, Browning, & Brooks-Gunn, 2010).

Fourth, this study suggests that lower levels of parental-perceived neighborhood disorder may be protective against depressive symptoms among adolescents. Low levels of parental-perceived neighborhood disorder were associated with lower levels of adolescent depressive symptoms; whereas high levels of parental-perceived neighborhood disorder were associated with high levels of depressive symptoms, exhibiting a dose-response relationship. Furthermore, low parent-perceived neighborhood disorder moderatesd the relationship between concentrated poverty and depressive symtpoms. The importance of disorder in poorer neighborhoods may be explained by the apparent breakdown of the social structure that is commonly attributed to areas of poverty (Ross & Mirowsky, 2001). The presence of litter, abandoned housing, and criminal activity creates a hostile living environment, leading to stress and fear. All of this may lead to psychological distress, having a negative impact on adolescent mental health and, therefore, depressive symptoms. To our knowledge, this is the first study that has examined the moderating role of parental perceptions of neighborhood disorder on

the association between adolescent depressive symptoms and neighborhood concentrated poverty. Only one other study of which we are aware has examined the moderating role of neighborhood perceptions on depressive symptoms (Erdem, Van Lenthe, Prins, Voorham, & Burdorf, 2016). That study was conducted among adults in the Netherlands where collective efficacy was found to be a moderator of psychological distress in neighborhoods with financial deprivation. Neighborhood disorder was not examined. In support of our findings, parental neighborhood perceptions have been found to moderate other adolescent behaviors and outcomes such as externalizing problems (Fite et al., 2010). In particular, our finding that concentrated poverty was negatively associated with adolescent depressive symptoms at low levels of parental-perceived neighborhood disorder may mean that low levels of neighborhood disorder may be more advantageous in areas with high poverty for the reduction of adolescent depressive symptoms, which warrants further study.

Findings must be considered with caution in light of the study limitations. First, due to the cross-sectional nature of the study, we cannot draw causal or directional conclusions about the relationship between neighborhood structural disadvantage and adolescent depressive symptoms. Second, the assessments of parental-perceived collective efficacy and neighborhood disorder were somewhat limited. Although the items used for assessment have been found to have moderate reliability, the items used may not have adequately measured the full constructs, particularly for parental-perceived collective efficacy. Therefore, we may not have accurately measured parental-perceived collective efficacy which could explain why no association was found between parental-perceived collective efficacy and adolescent depressive symptoms. Future research,

should use a more comprehensive measure of collective efficacy. Third, there may have been an influence from same-source bias. With same source bias, a person with depressive symptoms may assess their neighborhoods more negatively (Roux, 2007). In our study, we used parental perceptions to mitigate same source bias. However, if the adolescent's depressive symptoms were influencing the parent or the parent also had depressive symptoms, some degree of same-source bias may have occurred which would bias association between depressive symptoms and neighborhood disorder away from the null. Fourth, selection and non-response bias could have influenced our results. However, non-response bias was addressed using multiple imputation. Lastly, neighborhoods for the purposes of the current study were defined by census tract. In some cases, the parents and adolescents may consider a different boundry for their neighborhoods. Thus, there could have been some misclassifiation with respect to concentrated poverty which may have weakened observed associations. Despite this, there are study strengths. The use of a multi-informant assessment approach reduces concern about inflated correlations due to informant bias. Additionally, Add Health is a nationally representative study of adolescents in the U.S. with a diverse sample. It is one of the largest and most comprehensive studies among this population. Furthermore, we used a mixed model approach to estimate potential contextual and compositional effects in depressive symptoms among adolescents.

The results of the study suggest that the neighborhood environment is associated with adolescent depressive symptoms and that there may be a multiplicative effect between neighborhood poverty and disorder. Components of the neighborhood environment such as neighborhood disorder could serve as targets for the development of

multilevel or other intervention strategies aimed at reducing depression, particularly in areas that are structurally disadvantaged. Living in disadvantaged areas has been found to be linked with a variety of other poor health outcomes, particularly for adolescents (Witherspoon & Hughes, 2014). Therefore, if perceived neighborhood disorder can moderate that association, it may be a possible target for intervention.

Conclusions

Neighborhood disorder is a practical and feasible option as a target for structural interventions and should be considered. Interventions aimed at decreasing neighborhood disorder for mental health have been found to be promising (Casciano & Massey, 2012; Leventhal & Brooks-Gunn, 2003; Witherspoon & Hughes, 2014). A randomized-controlled trial aimed at changing the neighborhood structural environment of participants was found to decrease neighborhood disorder, resulting in an overall reduction in depressive and distress/anxiety symptoms (Leventhal & Brooks-Gunn, 2003). Furthermore, interventions with neighborhood disorder as a target have been successful for other behavioral health outcomes such as crime, alcohol abuse, and physical health (Braga & Bond, 2008; Casciano & Massey, 2012; Fauth, Leventhal & Brooks-Gunn, 2004; Leventhal & Brooks-Gunn, 2003). Moreover, a meta-analysis conducted on interventions targeting neighborhood disorder found that they were associated with an overall statistically significant reduction of crime lending credence to the applicability of such an intervention (Braga, Welsh, & Schnell, 2015). Moreover, consistent with our findings, an intervention targeting neighborhood disorder to reduce depressive symptoms among adolescents may be most effective in areas with high poverty.

An intervention targeting neighborhood disorder in order to decrease adolescent depressive symptoms may be implemented by utilizing strategies such as partnering with police departments and training residents to regulate their own community to reduce prostitution, limit gang activity, and remove litter on streets (Braga & Bond, 2008). These strategies may serve as viable options to begin the development of interventions to reduce neighborhood disorder. Moreover, the involvement of the entire community in such an intervention, especially adolescents, may have additional benefits. Not only may their mental health improve, but their physical health may benefit, as living in neighborhoods with higher levels of disorder have been found to be associated with substance use, sexual risky behavior, and obesity among adolescents (Dulin-Keita, Thind, Affuso, & Baskin, 2013; Furr-Holden et al., 2011; Lang et al., 2010). Given past research, neighborhood disorder may affect parenting strategies, leading to harsher parenting and family malfunctioning thereby increasing adolescent depressive symptoms (Byrnes & Miller, 2012). Family functioning was not able to be examined in the current study because it was not assessed in Add Health. Future research should examine this potential pathway to better understand how neighborhood disorder affects adolescent depressive symptoms, specifically parenting styles and strategies. Ultimately, addressing neighborhood structural disadvantage and improving neighborhood disorder may help to reduce depressive symptoms among adolescents and, subsequently, depression risk and prevalence, thereby reducing the growing mental health burden among adolescents.

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Tables and figures

Table 1
Descriptive characteristics of study sample, National Longitudinal Study of Adolescent to Adult Health, 1994–1995 (N=12,105)[†‡]

	Mean (SD)	Median (IQR)	Range	N (%)
Individual-level characteristics				
Age	15.5 (1.8)	16.0 (3.0)	11–21	-
Gender				-
Male		-	-	5780 (47.8)
Female		-	-	6324 (52.3)
Race/ethnicity				
White, Non-Hispanic		-	-	7423 (61.4)
Hispanic		-	-	1457 (12.1)
Other, Non-Hispanic		-	-	3215 (26.6)
Parent education				
College graduate		-	-	4023 (34.3)
Some college		-	-	1588 (13.5)
High school graduate		-	-	4354 (37.1)
Less than high school		-	-	1774 (15.1)
Parent occupation				
Professional/mangerial		-	-	1790 (15.2)
Other professional[§]		-	-	2177 (18.5)
Sales, service, administration		-	-	2867 (24.3)
Manual/blue collar		-	-	1448 (12.3)
Other (unspecified)		-	-	2716 (23.0)
Not working		-	-	800 (6.8)
Family income, in thousands of dollars	47.4 (56.0)	40.0 (39.0)	0–999	-
Family structure				
Two parents		-	-	7809 (64.9)
One parent		-	-	3530 (29.3)
Other		-	-	701 (5.8)
Parental-perceived collective efficacy	8.2 (1.6)	8.0 (3.0)	1–10	-
Parental-perceived neighborhood disorder	4.6 (1.5)	4.0 (2.0)	1–9	-
Adolescent depressive symptom score	11.0 (7.6)	10.0 (10.0)	0–54	-
Census-tract characteristics from the American Community Survey				
Concentrated poverty scale				
Quartile 1 (least)	-1.8 (0.3)	-1.8 (0.4)	-2.7–(-1.5)	-
Quartile 2	-1.1 (0.2)	-1.1 (0.4)	-1.5–(-0.7)	-
Quartile 3	0.0 (0.4)	0.0 (0.6)	-0.7–1.0	-
Quartile 4 (most)	2.8 (1.6)	2.4 (1.8)	1.0–12.9	-
Residential instability scale				
Quartile 1 (least)	-1.3 (0.6)	-1.2 (0.7)	-4.3–(-0.5)	-

Quartile 2	-0.2 (0.2)	-0.1 (0.3)	-0.5–0.1	-
Quartile 3	0.4 (0.1)	0.3 (0.2)	0.1–0.6	-
Quartile 4 (most)	1.1 (0.6)	0.9 (0.4)	0.6–4.8	-
Immigrant concentration scale				
Quartile 1 (least)	1.5 (0.5)	1.4 (0.7)	0.9–5.0	-
Quartile 2	0.5 (0.2)	0.5 (0.3)	0.2–0.9	-
Quartile 3	-0.2 (0.3)	-0.2 (0.5)	-0.7–0.2	-
Quartile 4 (most)	-1.9 (1.3)	-1.5 (1.4)	-7.5–(-0.7)	-

[†]Totals and percentages may not add up to the total sample size and 100, respectively, due to missing data and rounding

[‡]Due to rounding, values displayed may be zero

[§]Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations

Table 2. Bivariate analyses of the relation between characteristics of interest and adolescent depressive symptoms[†]

	Parametric tests		Nonparametric tests	
	Pearson ρ coefficient	p-value[‡]	Spearman ρ coefficient	p-value[‡]
Parental-perceived collective efficacy	-0.00	0.93	0.01	0.81
Parental-perceived neighborhood disorder	0.10	**≤0.001**	0.10	**≤0.001**
	F-statistic	p-value	Kruskal-Wallis x^2	p-value
Neighborhood structural disadvantage				
Concentrated poverty quartiles	55.76	**≤0.001**	180.58	**≤0.001**
Residential instability quartiles	6.49	**≤0.01**	21.95	**≤0.001**
Immigrant concentration quartiles	18.79	**≤0.001**	66.08	**≤0.001**

[†]Due to rounding, values displayed may be zero
[‡]P-values were adjusted using the Hommel correction

Table 3. Mixed effects multilevel models of adolescent depressive symptoms[†‡]

	Model 1		**Model 2**		**Model 3**	
	β Estimate	SE	β Estimate	SE	β Estimate	SE
Random effect						
Intercept	0.52**	0.17	0.52**	0.17	0.50**	0.17
Fixed effects						
Individual-level characteristics						
Age	0.36***	0.04	0.36***	0.04	0.35***	0.04
Gender						
Male	-	-	-	-	-	-
Female	1.75***	0.13	1.75***	0.13	1.75***	0.13
Race/ethnicity						
White, Non-Hispanic	-	-	-	-	-	-
Hispanic	0.87***	0.26	0.91***	0.26	0.87***	0.26
Other, Non-Hispanic	1.01***	0.18	1.01***	0.18	1.02***	0.18
Parent education						
College graduate	-	-	-	-	-	-
Some college	0.08	0.23	0.08	0.23	0.08	0.23
High school graduate	1.18***	0.18	1.17***	0.18	1.17***	0.18
Less than high school	2.70***	0.25	2.69***	0.25	2.70***	0.25
Parent occupation						
Professional/mangerial	-	-	-	-	-	-
Other professional[§]	0.01	0.24	0.01	0.24	-0.00	0.24
Sales, service, administration	0.42	0.24	0.42	0.24	0.41	0.24
Manual/blue collar	0.82**	0.28	0.82**	0.28	0.80**	0.29
Other (unspecified)	0.51*	0.23	0.51*	0.23	0.50*	0.23
Not working	0.59	0.35	0.59	0.36	0.58	0.36
Family income, in thousands of dollars	-0.00	0.00	-0.00	0.00	-0.00	0.00
Family structure						
Two parents	-	-	-	-	-	-
One parent	0.82***	0.17	0.82***	0.17	0.83***	0.17

Other	1.54***	0.31	1.54***	0.31	1.53***	0.31
Parental-perceived collective efficacy	0.00	0.05	-0.12	0.19	0.00	0.05
Parental-perceived neighborhood disorder	0.27***	0.05	0.27***	0.05	0.66**	0.21
Census-tract characteristics from the American Community Survey						
Concentrated poverty						
Quartile 1 (least)	-	-	-	-	-	-
Quartile 2	0.27	0.23	0.74	1.16	1.67*	0.77
Quartile 3	0.34	0.25	0.71	1.23	2.66***	0.80
Quartile 4 (most)	-0.00	0.30	-0.53	1.33	2.00*	0.85
Residential instability						
Quartile 1 (least)	-	-	-	-	-	-
Quartile 2	0.14	0.22	0.78	1.11	0.06	0.69
Quartile 3	0.03	0.23	0.19	1.18	-0.10	0.70
Quartile 4 (most)	0.29	0.23	-1.37	1.13	-0.17	0.68
Immigrant concentration						
Quartile 1 (least)	-	-	-	-	-	-
Quartile 2	0.16	0.27	-0.98	1.31	0.48	0.80
Quartile 3	0.25	0.27	-1.45	1.31	0.41	0.79
Quartile 4 (most)	0.48	0.25	-0.03	1.12	0.70	0.72
Interaction terms						
Parental-perceived collective efficacy						
Concentrated poverty x parental-perceived collective efficacy			-0.00	0.04		
Residential instability x parental-perceived collective efficacy			0.07	0.04		
Immigrant concentration x parental-perceived collective efficacy			0.03	0.04		
Parental-perceived neighborhood disorder						
Concentrated poverty x parental-perceived neighborhood disorder					-0.14**	0.05
Residential instability x parental-perceived neighborhood disorder					0.04	0.04
Immigrant concentration x parental-perceived neighborhood disorder					-0.02	0.04

*p<0.05
**p≤0.01
***p≤0.001

[†]Multiple imputation was used to deal with missing data
[‡]Due to rounding, values displayed may be zero
[§]Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations

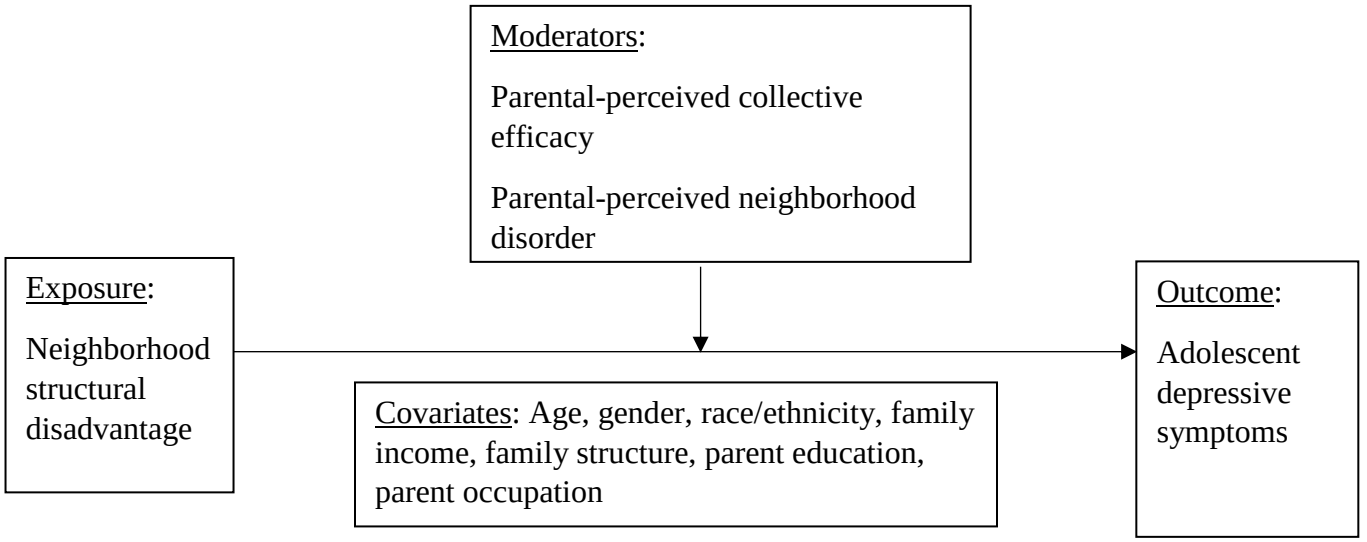
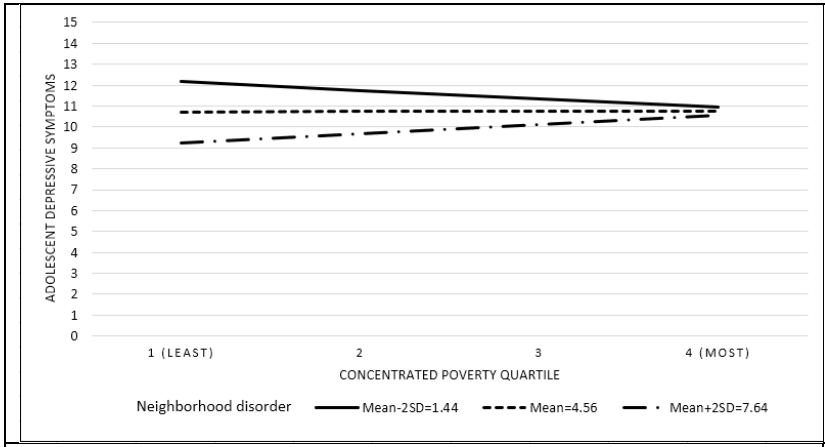
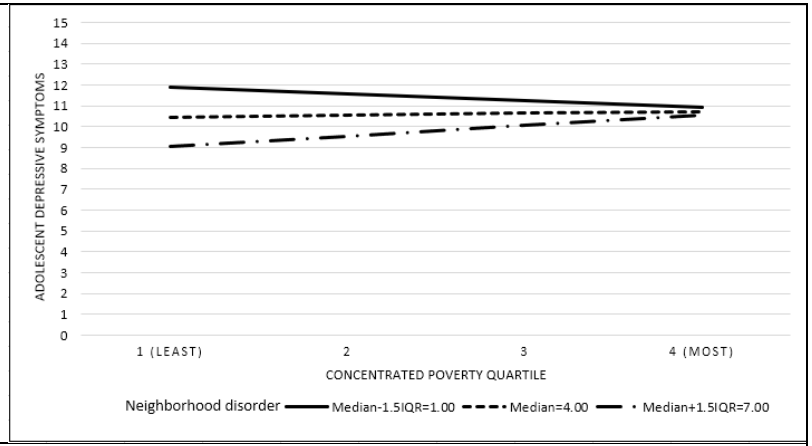


Figure 1. Adapted theoretical framework from Hill & Maimon (2013) linking neighborhood structural disadvantage and adolescent depressive symptoms





A

	β Estimate	**SE**
Parental-perceived neighborhood disorder		
Mean-2SD	-0.41*	0.16
Mean	0.03	0.08
Mean+2SD	0.46**	0.16

B

	β Estimate	**SE**
Parental-perceived neighborhood disorder		
Median-1.5IQR	-0.32*	0.14
Median	0.11	0.09
Median+1.5IQR	0.53**	0.17

Figure 2. Conditional estimates of concentrated poverty on adolescent depressive symptoms by levels of parental-perceived neighborhood disorder at the mean (A) and median (B) of depressive symptoms. *Note:* Conditional beta (β) estimates were calculated adjusted for covariates and interactions from Table 3 Model 3. SE is standard error. Bold *SE* is standard error. Significance values: *p<0.05, **p≤0.01

Appendix A

Principal component analysis factor loadings[†]

	Neighborhood structural disadvantage		
	Concentrated poverty	Residential instability	Immigrant concentration
Proportion households with public assistance income	0.445474	0.174395	0.213811
Unemployment rate	0.429372	0.038807	0.224526
Proportion family households that are female householder, no husband present, households	0.449317	-0.157294	0.145397
Proportion persons with income in 1989 below poverty level	0.453276	0.021832	0.180962
Proportion aged 5 and over in same house as in 1985	-0.071204	0.727903	0.403055
Proportion occupied housing units that are owner-occupied	-0.365480	0.343041	0.292980
Proportion Hispanic origin	0.214376	0.387859	-0.524313
Proportion foreign born	0.158889	0.380668	-0.571656

[†]All variables were standardized with a mean of 0 and a standard deviation of 1

Appendix B

Bivariate analyses of the relation between individual-level characteristics and adolescent depressive symptoms[†]

	Parametric tests		Nonparametric tests	
	Pearson ρ coefficient	p-value[‡]	Spearman ρ coefficient	p-value[‡]
Age	0.10	**≤0.001**	0.10	**≤0.001**
Family income	-0.08	**≤0.01**	-0.14	**≤0.01**
	F-statistic	p-value	Kruskal-Wallis x^2/Wilcoxon statistic	p-value
Gender	-13.15	**≤0.001**	32715957.50	**≤0.001**
Race/ethnicity	94.24	**≤0.001**	208.79	**≤0.001**
Parent education	140.05	**≤0.001**	414.62	**≤0.001**
Parent occupation	40.28	**≤0.001**	213.81	**≤0.001**
Family structure	108.87	**≤0.001**	203.70	**≤0.001**

[†]Due to rounding, values displayed may be zero

[‡]P-values were adjusted using the Hommel correction

Appendix C

Bivariate analyses of the relation between characteristics of interest and neighborhood structural disadvantage

	Parametric tests			Nonparametric tests		
	Concentrated poverty F-statistic (p-value†)	Residential instability F-statistic (p-value†)	Immigrant concentration F-statistic (p-value†)	Concentrated poverty Kruskal-Wallis x^2 (p-value†)	Residential instability Kruskal-Wallis x^2 (p-value†)	Immigrant concentration Kruskal-Wallis x^2 (p-value†)
Parental-perceived collective efficacy	9.71 **(≤0.001)**	0.72 (0.93)	63.46 **(≤0.001)**	71.84 **(≤0.001)**	3.56 (0.81)	205.75 **(≤0.001)**
Parental-perceived neighborhood disorder	470.71 **(≤0.001)**	3.58 (0.08)	135.45 **(≤0.001)**	1050.39 **(≤0.001)**	8.63 (0.17)	370.93 **(≤<0.001)**
Adolescent depressive symptom score	55.76 **(≤0.001)**	6.49 **(≤0.01)**	18.79 **(≤0.001)**	180.58 **(≤0.001)**	21.95 **(≤0.001)**	66.08 **(≤0.001)**

†P-values were adjusted using the Hommel correction

Appendix D

Mixed effects multilevel models examining sex differences in adolescent depressive symptoms[†‡]

	Model 1		**Model 2**	
	β Estimate	SE	β Estimate	SE
Random effect				
Intercept	0.52**	0.17	0.50**	0.17
Fixed effects				
Individual-level characteristics				
Age	0.36***	0.04	0.35***	0.04
Gender				
Male	-	-	-	-
Female	1.62*	0.74	1.10*	0.48
Race/ethnicity				
White, Non-Hispanic	-	-	-	-
Hispanic	0.92***	0.26	0.88***	0.26
Other, Non-Hispanic	1.02***	0.18	1.02***	0.18
Parent education				
College graduate	-	-	-	-
Some college	0.05	0.23	0.06	0.23
High school graduate	1.17***	0.19	1.16***	0.19
Less than high school	2.68***	0.25	2.69***	0.25
Parent occupation				
Professional/mangerial	-	-	-	-
Other professional[§]	0.00	0.24	-0.00	0.24
Sales, service, administration	0.45	0.24	0.44	0.24
Manual/blue collar	0.84**	0.29	0.82**	0.29
Other (unspecified)	0.51*	0.23	0.50*	0.23
Not working	0.61	0.36	0.61	0.36
Family income, in thousands of dollars	-0.00	0.00	-0.00	0.00

Family structure				
Two parents	-	-	-	-
One parent	0.83***	0.17	0.84***	0.17
Other	1.53***	0.32	1.51***	0.32
Parental-perceived collective efficacy	-0.04	0.21	0.00	0.05
Parental-perceived neighborhood disorder	0.27***	0.05	0.71**	0.22
Census-tract characteristics from the American Community Survey				
Concentrated poverty				
Quartile 1 (least)	-	-	-	-
Quartile 2	0.83	1.20	1.82*	0.75
Quartile 3	0.69	1.23	2.70***	0.74
Quartile 4 (most)	-0.57	1.38	2.14**	0.82
Residential instability				
Quartile 1 (least)	-	-	-	-
Quartile 2	0.81	1.17	-0.02	0.66
Quartile 3	0.31	1.23	-0.20	0.68
Quartile 4 (most)	-1.22	1.11	-0.23	0.65
Immigrant concentration				
Quartile 1 (least)	-	-	-	-
Quartile 2	-0.92	1.33	0.61	0.80
Quartile 3	-1.44	1.38	0.50	0.80
Quartile 4 (most)	-0.02	1.10	0.70	0.73
Interaction terms				
Parental-perceived collective efficacy				
Concentrated poverty x parental-perceived collective efficacy x gender	-0.01	0.01		
Residential instability x parental-perceived collective efficacy x gender	0.01	0.01		
Immigrant concentration x parental-perceived collective efficacy x gender	0.02	0.01		
Parental-perceived neighborhood disorder				
Concentrated poverty x parental-perceived neighborhood disorder x gender			-0.03	0.02
Residential instability x parental-perceived neighborhood disorder x gender			0.03	0.02
Immigrant concentration x parental-perceived neighborhood disorder x gender			0.04	0.02

*p<0.05
**p≤0.01
***p≤0.001
†Multiple imputation was used to deal with missing data
‡Due to rounding, values displayed may be zero
§Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations

MANUSCRIPT 2

Perceived neighborhood social cohesion moderates the relationship between neighborhood structural disadvantage and adolescent depressive symptoms

Abstract

Aims: There is a dearth of research exploring the moderating role of the social environment on neighborhood structural disadvantage and depressive symptoms, particularly among adolescents. Therefore, we examined if adolescent perceptions of neighborhood social cohesion and safety moderated the association between neighborhood structural disadvantage and adolescent depressive symptoms. **Methods:** This cross-sectional study used data from the National Longitudinal Study of Adolescent to Adult Health (Add Health). The study sample consisted of 12,105 adolescents enrolled in 9th–12th grades during the 1994–1995 school year across the United States (U.S.). Mixed effects multilevel modeling was used to determine if adolescent perceptions of neighborhoods moderated the relationship between neighborhood structural disadvantage and adolescent depressive symptoms. **Results:** Results showed that perceived neighborhood social cohesion moderated the relationship between neighborhood structural disadvantage and adolescent depressive symptoms ($p \leq 0.001$). At higher levels of perceived neighborhood social cohesion, neighborhood structural disadvantage was associated with decreased depressive symptoms. **Conclusion:** Findings suggest that improving perceived neighborhood social cohesion may decrease adolescent depressive symptoms, particularly in neighborhoods with high disadvantage. This aspect of the neighborhood social environment may serve as a target for structural and other interventions to address the growing burden of depression among adolescents.

Keywords: Adolescents; depressive symptoms; neighborhood structural disadvantage; neighborhood social environment

Introduction

Depression is a common health condition experienced by adolescents and is becoming more common (Mojtabai, Olfson, & Han, 2016). The 12-month prevalence of major depressive episodes (MDE) in adolescents was 12.8% in 2016 compared to 8.7% in 2005 in the United States (U.S.) (Mojtabai, Olfson, & Han, 2016; National Institute of Mental Health, 2017). This is concerning because adolescent depression is a predictor of health risk behaviors and poor health outcomes later in life, including sexual risk-taking (Jackson, Seth, DiClemente, & Lin, 2015), sexually transmitted infections (STIs) (Jackson, Seth, DiClemente, & Lin, 2015), obesity (Schwartz et al., 2016), comorbid psychiatric disorders such as chronic depression and suicide (Goldston et al., 2016; Thapar, Collishaw, Pine, & Thapar, 2012), substance use (Maslowsky, Schulenberg, & Zucker, 2014), and criminal behavior (Anderson, Cesur, & Tekin, 2015). Depression not only affects the individual adolescent, but also the community at large. Depression among adolescents leads to increased expenditures for in- and out-patient costs in the public health sector (Wright et al., 2016).

Much of the research on depression among adolescents has focused on individual- and family-level predictors and correlates (Cairns, Yap, Pilkington, & Jorm, 2014). However, in recent years, research has begun to focus on how the neighborhood environment influences depression. Aspects of the neighborhood environment that have been increasingly studied are social cohesion, neighborhood safety, and neighborhood structural disadvantage. *Social cohesion* is defined as “neighbors knowing, helping, and

trusting each other" and is a component of collective efficacy, which refers to the willingness of neighborhood residents to work together for the common good (Sampson, Raudenbush, & Earls, 1997). In contrast, *neighborhood structural disadvantage* refers to the lack of institutional, social, and material resources (Hill & Maimon, 2013).

Social cohesion, neighborhood safety, and neighborhood structural disadvantage have been shown to be linked to depression among adolescents. A longitudinal study conducted in Canada found that higher levels of social cohesion predicted adolescents having fewer depressive symptoms (Kingsbury et al., 2015). In addition, among a sample of urban Midwestern African American adolescents, increased levels of social cohesion were correlated with lower levels of depressive symptoms (Hurd, Stoddard, & Zimmerman, 2013). In a sample of Black youth, those who perceived their neighborhoods as unsafe had higher odds of major depressive disorder (Assari, & Caldwell, 2017). Furthermore, a study conducted in California found that adolescents who perceived their neighborhoods as unsafe were two times more likely than those who perceived their neighborhoods as safe to report serious psychological distress (Goldman-Mellor, Margerison-Zilko, Allen, & Cerda, 2016).

Findings related to the association between neighborhood structural disadvantage and depressive symptoms have been mixed (Simons et al., 2002; Xue, Leventhal, Brooks-Gunn, & Earls, 2005). A housing mobility intervention conducted among families in Baltimore, Boston, Chicago, Los Angeles, and New York, showed that boys residing in disadvantaged neighborhoods had increased risk of depressive symptoms (Kessler et al., 2014). Specifically, among African American adolescents, higher neighborhood disadvantage predicted greater internalizing symptoms (Hurd, Stoddard, & Zimmerman,

2013). However, another study among African American children did not find that neighborhood disadvantage was correlated with depressive symptoms (Simons et al., 2002). Neighborhood structural disadvantage was not associated with higher levels of depression severity among 5–11 year-olds in Chicago after full adjustment for other covariates (Xue, Leventhal, Brooks-Gunn, & Earls, 2005).

The manner in which neighborhood structural disadvantage may exert its influence on depression is poorly understood, and there have been calls to examine potential pathways (Blair, Ross, Gariepy, & Schmitz, 2014). Studies examining potential mechanisms of neighborhood structural disadvantage on depressive symptoms have mainly focused on mediators. However, the findings of these studies have been inconclusive (Bassett, & Moore, 2013; Joshi et al., 2017; Lee & Liechty, 2015), and not all studies have found that social cohesion acts as a mediator. Studies exploring the moderating role of social cohesion and neighborhood safety on the relationship between neighborhood structural disadvantage and depression are nonexistent, particularly among adolescents. A better understanding of the underlying mechanisms is needed to develop effective multilevel interventions.

In addition, many of the studies examining neighborhood structural disadvantage, neighborhood perceptions, and depressive symptoms have focused on adults or young children (i.e., not adolescents). Focusing on adolescents is imperative given the potential implications that the structural and social environment may have on adolescent depressive symptoms (Hurd, Stoddard, & Zimmerman, 2013; Kingsbury et al., 2015). Studies on adolescents have been limited by small sample sizes, geographically restricted, and lacked racial/ethnic diversity. The studies on adolescents were conducted

either outside the U.S. (i.e., Canada) or focused on U.S. subpopulations (i.e., African Americans) in select parts of the country. Despite this, study findings suggest that in the presence of neighborhood structural disadvantage, increased levels of social cohesion among adolescents may help to alleviate depressive symptoms, putting them at a lower risk of depression (Hurd, Stoddard, & Zimmerman, 2013; Kingsbury et al., 2015; Xue, Leventhal, Brooks-Gunn, & Earls, 2005).

Theoretical framework

The proposed study was guided by the Ecological Systems Theory of Human Development (Bronfenbrenner, 1994) and the theoretical framework linking neighborhoods to mental health outcomes, specifically depression, by Hill and Maimon (2013). These two theories were integrated due to their focus on youth development and neighborhood influence on mental health. The Ecological Systems Theory of Human Development posits that child development is influenced by the interaction between the individual and his/her environment. The environment can be divided into various subsystems including the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. For the purposes of the proposed study, only the exosystem, which consists of the neighborhood-community context, was examined. The exosystem contains events that influence processes within the immediate environment in which a developing person lives. These processes can influence the psychological development of an adolescent in a positive or negative way, thereby impacting mental health. A theoretical framework proposed by Hill and Maimon (2013), helps elucidate the relationship between the neighborhood environment and depression. With its origins in social disorganization theory and grounded by empirical evidence, the framework shows how

neighborhood structural disadvantage may influence depression itself but can be impacted by individual characteristics, such as perceptions of the neighborhood (Hill & Maimon, 2013). The theoretical framework shown in Figure 1 shows the adaptation of the theoretical framework by Hill & Maimon (2013) for the proposed study, which focuses solely on adolescents.

Study aims

The objective of the current study was to determine the moderating role of perceived neighborhood social cohesion on the association between neighborhood structural disadvantage and depressive symptoms among U.S. adolescents using our adapted theoretical framework. Moderation was examined due to our adapted theoretical framework drawing on the Ecological Systems Theory of Human Development (Bronfenbrenner, 1994) and the theoretical framework linking neighborhoods to mental health outcomes by Hill and Maimon (2013), which indicates that perceived neighborhood social cohesion may act as a potential moderator. We hypothesized that as perceived neighborhood social cohesion increases, the relationship between neighborhood structural disadvantage and levels of depressive symptoms among U.S. adolescents weakens. Percieved neighborhood safety was also examined as a potential moderator of interest. Findings from this study could help elucidate how the neighborhood environment impacts depressive symptoms and identify neighborhood characteristics that may serve as targets for multilevel interventions to prevent or decrease depressive symptoms among adolescents in the U.S.

Methods

Study design

This cross-sectional study used data from the 1994–1995 National Longitudinal Study of Adolescent to Adult Health (Add Health) to assess the moderating role of perceived neighborhood social cohesion on the association between neighborhood structural disadvantage and depressive symptoms among adolescents (Harris, 2009). Add Health is a nationally representative school-based study designed to determine the developmental trajectories of adolescents into adulthood. Additionally, it assesses adolescent perceptions in relation to their neighborhood. A detailed description of the Add Health methodology can be found elsewhere (Harris, 2011; Harris, 2013).

The study sample was restricted to adolescents who completed the in-home questionnaire, which contained information on neighborhoods needed to address the objective of the study (N=20,745). The sample was further restricted to the core sample due to weights not being available at the neighborhood level to account for unequal probability of selection, bringing the final sample size to N=12,105 (Chen & Chantala, 2014). The core sample is essentially self-weighting as not all students had an equal probability of being included in the study (Chen & Chantala, 2014). To obtain the core sample, U.S. schools were sampled based on region, urbanicity, size, type, and ethnic composition of the target population. For a school to be eligible, it had to have an 11th grade and more than 30 enrolled students. Students who completed the in-school questionnaire and students who did not complete the in-school questionnaire, but were still on the school roster, were eligible for selection. Students were stratified by grade and

sex. About 17 students were randomly chosen from each stratum so that approximately 200 adolescents were selected from each of the 80 pairs of schools.

For the in-home questionnaire, data were collected at the respondent's home using computer-assisted personal interviewing (CAPI) and computer-assisted self-interviewing (CASI). Additionally, parents of the core student sample were asked to complete a parent questionnaire. The mother or other female head of household was the preferred respondent because results from previous studies indicated that mothers tended to be more aware than fathers of their child's schooling, health behaviors, and health status. However, parents could complete the questionnaire at a later time point if they were unavailable. Approval was obtained from the Florida International University Institutional Review Board prior to conducting the study.

Measures

Depressive symptoms. Depressive symptoms were assessed using 19 out of the 20 items from the Center for Epidemiologic Studies Depression Scale (CES-D) used in Add Health. The 19-item scale has been found to have high reliability (Jacobson & Rowe, 1999; Wight, Botticello, & Aneshensel, 2006). The Cronbach's alpha was calculated for the sample used for the current study and was 0.88. For each item, respondents had to choose how often each statement was true in the past week. Respondents could choose "never or rarely," "sometimes," "a lot of the time," or "most of the time or all of the time." A sample item is: "You were happy." To obtain a depressive symptoms score, items were summed while taking reverse coding into consideration. The depressive symptoms score was treated as a continuous variable. Higher scores indicated higher levels of depressive symptoms.

Neighborhood structural disadvantage index. The index consisted of the following items: proportion of female-headed households with children aged <18 years, unemployment rate, proportion of households receiving public assistance, proportion of nonelderly residents with income below the poverty line, and proportion of African Americans (Burdette & Needham, 2012). Each item was assessed at the census-tract level taken from the Add Health Contextual I database. This database includes neighborhood variables from 19 sources such as the Alan Guttmacher Institute, National Center for Health Statistics, and U.S. Census Bureau (Billy, Wenzlow, & Grady, 1998). These variables are at multiple geographic levels (e.g. state, county census tract, and census block) for each participant. The specific geographic area for each participant was derived from geocoded addresses of participants. Scores for the neighborhood structural disadvantage index were obtained by conducting principal component analysis. Factor loadings from the first principal component were used as weights to arrive at a score for each census tract (or neighborhood). All values were standardized with a mean of zero and a standard deviation of one prior to conducting principal component analysis due to differences in units of measurement (Ringnér, 2007). Scores were ranked into quartiles so that the first quartile (Quartile 1) represented the least disadvantaged neighborhoods to facilitate interpretation.

Perceived neighborhood social cohesion. Perceived neighborhood social cohesion was assessed by adolescent respondents indicating if the following 3 items were true: “In the past month, you have stopped on the street to talk with someone who lives in your neighborhood,” “You know most of the people in your neighborhood,” and “People in this neighborhood look out for each other.” Items were summed while taking into

consideration reverse coding with higher scores indicating higher levels of perceived neighborhood social cohesion. The items have been found to have moderate reliability (Cronbach's alpha=0.60) (Donnelly, 2015).

Perceived neighborhood safety. Perceived neighborhood safety was assessed by adolescent respondents with the following item, "Do you usually feel safe in your neighborhood?" It was treated as a dichotomized categorical variable coded as no or yes.

Covariates. Age, gender, race/ethnicity, family structure, family income, parent occupation, and parent education were adjusted for in the analysis. Age was assessed as a continuous measure reported by the adolescent. Gender was assessed as the participants' biological sex. It was treated as a dichotomized categorical variable coded as male or female. Race/ethnicity was assessed as a categorical variable and coded as non-Hispanic White, Hispanic, non-Hispanic Black or African American, non-Hispanic Asian or Pacific Islander, non-Hispanic American Indian or Native American, and non-Hispanic other. Family structure was assessed as a categorical variable coded as two-parent, one-parent, and other structured household. Family income was assessed as a continuous variable and reported by the parent in thousands of dollars as the total amount of income, before taxes, the family received in 1994. Parent occupation was assessed as a categorical variable reported by the adolescent for each parent based on U.S. Census Bureau classifications and were ranked as follows: 1) professional/managerial, 2) other professional, which included community/social services, education/training/library, and arts/design/entertainment/sports/media occupations; 3) sales, service, and administration; 4) manual/blue collar, 5) other (unspecified), and 6) not working. The highest occupation of either parent was used as the value for the variable. Parent education was taken as a

categorical variable reported by the adolescent. It was coded as college graduate, some college, high school graduate, and less than high school. The highest educational level for either parent was used as the value for the variable.

Statistical analysis

Descriptive statistics included counts and percentages for categorical variables. For continuous variables, medians and interquartile ranges were calculated due to normality tests of residuals performed indicating a non-normal distribution ($p<0.001$; data not shown). Bivariate analyses were conducted to determine the association between neighborhood structural disadvantage, neighborhood perceptions, and adolescent depressive symptoms. Non-parametric tests Spearman's rho for continuous variables and Kruskal-Wallis for categorical variables were performed. Correlations and chi-square statistics along with p-values are reported.

Mixed effects multilevel models were used to test the association between neighborhood perceptions and depressive symptoms as well as interactions between neighborhood perceptions and neighborhood structural disadvantage on depressive symptoms (SAS Institute, 2013a). The distribution of the depressive symptoms score, perceived neighborhood social cohesion, age, and family income was not normal; therefore, a square root transformation was used for these variables. Prior to modeling, transformations (i.e. log, log base of 10, square root, quadratic, and cubic) of the data were considered to as ways to approximate a normal distribution. Subsequent normality tests resulted in a significant p-value ($p<0.001$; data not shown), indicating non-normality. However, normality tests are generally conservative, and the modeling used is considered sufficiently robust to withstand a certain level of violations of assumptions. A

square root transformation improved the distribution of the data compared to other transformations due to a skewness of 0.04 and a kurtosis of 0.21. Therefore, a square root transformation was performed on the data. All multilevel models were conducted using the transformed data.

Multilevel models were fitted in stages to evaluate individual- and neighborhood-level characteristics associated with adolescent depressive symptoms. The first model was the empty model, which included only the census tract random effect. The second included the census tract random effect and individual-level characteristics, including adolescent neighborhood perceptions. The third model included all the variables in the second model as well as the neighborhood structural disadvantage index. The fourth model additionally included the interaction terms. For any significant interactions, conditional beta estimates were calculated using the fully adjusted model for the square root of perceived neighborhood social cohesion at the median (highest level), median-3[interquartile range (IQR)] (intermediate level), and median-6IQR (lowest level) to provide a wide enough range of values to evaluate moderation. The median was the highest level at which to evaluate the interaction since the median for the transformed variable was at the highest possible value (median=2.45, range 1–2.45). Median scores and the interquartile range at which to evaluate significant interactions were used due to non-normal distribution of the transformed data. Graphs were generated for visual representation of the interactions. Estimates obtained from the models included the following: 1) intraclass correlation (ICC), 2) β (beta) estimates, 3) standard errors (SE), and 4) p-values. The alpha level applied to test significance was 0.05, including for the interaction terms.

A sensitivity analysis was performed to assess the potential issue of same source bias and reverse causality by excluding all participants with elevated depressive symptoms. The number of participants excluded with high depressive symptoms was 2,100 leading to a total sample size of N=10,005 for the sensitivity analysis. Elevated depressive symptoms were determined by using a clinical cutoff CES-D score of ≥18 following Mendle, Ferrero, Moore, and Harden (2013). The main analysis was repeated using the reduced sample to determine whether depressed adolescents were driving the cross-level interactions between the perceived neighborhood environment and depressive symptoms.

Multiple imputation was used to handle missing data. PROC MI was used to perform imputation and PROC MIANALYZE was used for pooling the estimates in SAS. Imputation methods used were linear regression and the discriminant function for continuous and categorical variables, respectively (Yaun, 2010). Twenty-five imputed datasets were created, following White, Royston, and Wood's (2011) recommendation that the number of imputed datasets should equal the percentage of incomplete cases. The highest percentage of incomplete cases for a variable was for family income (percentage of incomplete cases was 24.2%, which was rounded up to the nearest whole number to obtain the number of datasets to be imputed). The percentage of missing data for all other variables was relatively low, ranging from 0.01–0.07%. All variables used in the analysis model, including the outcome, were used in the imputation model, as well as all interaction terms except for the census tract ID, to obtain adequate results (He, 2010). The sample size of each dataset was 12,105 after imputation. However, for the analysis the sample size decreased to N=11,977 due to missing census tract IDs for 128

participants. No weighting was applied to the data. Analyses were conducted using SAS v9.4 statistical software (SAS Institute, 2013b).

Results

Sample

The median age of the study sample was 16 [interquartile range (IQR)=3.0, range 11–21] (Table 1). The majority of participants were non-Hispanic White (61.4%), female (52.3%), and came from a two-parent family household (64.9%). The median perceived neighborhood social cohesion score was 6.0 (IQR=1.0, range 1–6). A high percentage (89.8%) of adolescents perceived their neighborhood as being safe. Adolescent depressive symptom scores were in the mild range (median=10.0, IQR=10.0, range 0–54). Additional sample characteristics including individual- and neighborhood-level can be found in Table 1.

Preliminary analyses

Normality tests of residuals were performed indicating a non-normal distribution for the depressive symptoms score, age, perceived neighborhood social cohesion, and family income ($p<0.001$; data not shown). Due to this, descriptive statistics included medians and interquartile ranges using the non-transformed variables for continuous variables as well as counts and percentages for categorical variables. For bivariate analyses, non-parametric tests Spearman's rho for continuous variables and Kruskal-Wallis for categorical variables were performed.

The first model was the empty model, which included only the census tract random effect. From this model the ICC was calculated to be 0.03, although low is typical for observational studies (Killip, Mahfoud, & Pearce, 2004). The design effect

was 1.18 and 1.03, for the mean and the median number of participants in a census tract, respectively. The mean and median were used to calculate the design effect due to the high number of census tracts with only 1 participant. Although the ICC and design effects were small, we were interested in level-2 as well as level-1 effects. Therefore, a multilevel model was considered appropriate for the study to control for the neighborhood environment in order to obtain unbiased estimates (Killip, Mahfoud, & Pearce, 2004; Lai & Kwok, 2015).

Bivariate analysis

Table 2 shows the bivariate analyses between variables of interest. Adolescent depressive symptoms scores were significantly associated with the neighborhood structural disadvantage index (p-value ≤0.001), perceptions of neighborhood social cohesion (p-value ≤0.001), and safety (p-value ≤0.001). All individual-level characteristics were significantly associated with adolescent depressive symptoms (p-value ≤0.001; data not shown). Due to our interest in effect modification, additional bivariate analyses between neighborhood perceptions and the neighborhood structural disadvantage index were conducted. Results showed that perceived neighborhood social cohesion (x^2=27.26, p≤0.001) and safety (x^2=349.20, p≤0.001) were each associated with neighborhood structural disadvantage.

Associations of perceived neighborhood social cohesion and safety with depressive symptoms

The results of the multilevel models for perceived neighborhood social cohesion and perceived neighborhood safety are given in Table 3. Perceived neighborhood social cohesion was associated with depressive symptoms among adolescents after adjustment

for individual characteristics and the neighborhood structural disadvantage index ($p \leq 0.001$) in Model 3. Every unit increase in the square root of perceived neighborhood social cohesion corresponded to a 0.24 unit decrease in the square root of depressive symptoms (SE=0.04). Also, perceived neighborhood safety was associated with depressive symptoms in adolescents ($p \leq 0.001$) in Model 3. Compared to adolescents who did not perceive their neighborhood as being safe, those who did perceive their neighborhood as being safe had a 0.47 unit (SE=0.04, $p \leq 0.001$) lower square root of depressive symptoms score. The neighborhood structural disadvantage index was not associated with depressive symptoms.

Moderation by perceived neighborhood social cohesion and safety

The interaction term between neighborhood structural disadvantage and the square root of perceived neighborhood social cohesion was significant ($p \leq 0.001$), but for perceived neighborhood safety it was not (Table 3, Model 4). Figure 2a shows the graphical representation of the structural disadvantage-social cohesion interaction adjusted for covariates and interactions from Table 3, Model 4. Conditional estimates for the neighborhood structural disadvantage quartiles by the square root of perceived neighborhood social cohesion at the median (highest levels), median-3IQR (intermediate levels), and median-6IQR (lowest levels) are also displayed in Figure 2a. At the lowest (median-6IQR) levels of the square root of perceived neighborhood social cohesion, neighborhood structural disadvantage was associated with a decrease in the square root of depressive symptoms as depicted by the slope and conditional estimate (β=-0.05, SE=0.07, $p \geq 0.05$). However, this association was not statistically significant. Similarly, the slopes and conditional estimates at intermediate (median-3IQR) (β=-0.13, SE=0.06,

p<0.05) and higher levels (median) (β=-0.22, SE=0.07, p≤0.01) of the square root of perceived neighborhood social cohesion show that neighborhood structural disadvantage was associated with a decrease in the square root of depressive symptoms. The associations for the intermediate (median-3IQR) and higher (median) levels of the square root of perceived neighborhood social cohesion were statistically significant with the greatest decrease in depressive symptoms seen at the highest (median) levels of perceived neighborhood social cohesion as seen in the figure.

Sensitivity analysis

The sensitivity analysis excluding all participants with elevated depressive symptoms (N=10,005) revealed similar results for the variables of interest. However, estimates were attenuated. The model with individual- and neighborhood-level variables showed that both the square root of perceived neighborhood social cohesion and perceived neighborhood safety were significantly associated with a 0.14 (SE=0.04, p≤0.001) and 0.21 (SE=0.03, p≤0.001) decrease in the square root of depressive symptoms, respectively (see Appendix A, Model 3). These betas were smaller than those for the full sample (-0.24 and -0.47 respectively). As in the full model, the interaction term for the neighborhood structural disadvantage index and perceived neighborhood social cohesion was significant but the interaction term with perceived neighborhood safety was not.

The graphical representation of the interaction and the conditional estimates for the neighborhood structural disadvantage quartiles by the square root of perceived neighborhood social cohesion at the median (highest levels), median-3IQR (intermediate levels), and median-6IQR (lowest levels) for the sensitivity analysis using the restricted

sample are displayed in Appendix B, Figure 2b. The figure shows that at the lowest (median-6IQR) (β=-0.01, SE=0.06, p≥0.05) and intermediate (median-3IQR) (β=-0.08, SE=0.06, p≥0.05) levels of the square root of perceived neighborhood social cohesion, neighborhood structural disadvantage was associated with a decrease in the square root of depressive symptoms as shown by the slopes and conditional estimates. However, these associations were not statistically significant. At higher (median) levels (β=-0.15, SE=0.07, p<0.05) of the square root of perceived neighborhood social cohesion, neighborhood structural disadvantage was associated with a decrease in the square root of depressive symptoms as depicted by the slope and conditional estimate, which was statistically significant. This differs from what was found for the full sample, in which neighborhood structural disadvantage was associated with a decrease in depressive symptoms for both the intermediate (median-3IQR) (β=-0.13, SE=0.06, p<0.05) and higher levels (median) (β=-0.22, SE=0.07, p≤0.01) of the square root of perceived neighborhood social cohesion.

Discussion

The current study examined relationships between neighborhood structural disadvantage, neighborhood perceptions, and adolescent depressive symptoms. Using a nationally representative sample of adolescents, we examined potential moderating factors that may mitigate the effects of living in a disadvantaged neighborhood on depression. To our knowledge, this is the first study that has conducted such an examination among adolescents, a population experiencing an increase in depression over the last decade. Our findings extend our knowledge of how neighborhood structural

disadvantage and the social environment of communities may influence mental health among adolescents.

Overall, we found that in addition to individual-level factors, adolescent perceptions of higher neighborhood social cohesion and safety were associated with lower levels of depressive symptoms. Neighborhood structural disadvantage was associated with higher levels of depressive symptoms, but not in the moderation analysis. In the moderation analysis, when perceived neighborhood social cohesion was high, a reduction in depressive symptoms was seen in each quartile of neighborhood structural disadvantage with the greatest reduction in the most disadvantaged quartiles. Thus, there is a protective relationship between neighborhood structural disadvantage and depressive symptoms at high levels of perceived neighborhood social cohesion. Therefore, our hypothesis was partially supported as well as our adapted theoretical framework. These results may indicate that at high levels of perceived neighborhood social cohesion, there are no negative effects of neighborhood structural disadvantage on depressive symptoms. Similar results were found in a study conducted among adults in the Netherlands (Erdem, Van Lenthe, Prins, Voorham, & Burdorf, 2016). Significant interaction effects were found between neighborhood social cohesion and socioeconomic status. Individuals with financial deprivation living in neighborhoods with high social cohesion had lower psychological distress compared to those living in neighborhoods with low social cohesion. In addition, those who received disability, social assistance, or unemployment benefits and were living in high socially cohesive neighborhoods had lower psychological distress than those living in low socially cohesive neighborhoods. Despite this study being conducted among an adult population and examining psychological

distress, it does lend support to our findings as it shows that neighborhood social cohesion may moderate the relationship between different aspects of disadvantage and mental health. Although perceived neighborhood safety was found to be associated with depressive symptoms, it was not found to moderate the association between depressive symptoms and neighborhood structural disadvantage. It is possible that the mechanism by which perceived neighborhood safety influences depression is different from that of perceived neighborhood social cohesion (i.e. mediation and not moderation) although it should be noted that there was only a small proportion of adolescents who perceived their neighborhood as not safe. It has been reported that internalized experiences with violence due to living in unsafe neighborhoods may influence depressive symptoms via perceptions of neighborhood disorder (Curry, Latkin, & Davey-Rothwell, 2008). Alternatively, it is possible that self-selection of families of adolescents with high depressive symptoms could have accounted for our findings (e.g., families of adolescents with high depressive symptoms moved to disadvantaged neighborhoods, perhaps due to a third variable such as low socioeconomic status). However, a sensitivity analysis revealed similar results when participants with high depressive symptoms were excluded.

The associations found between perceptions of the neighborhood social environment and adolescent depressive symptoms are in line with the existing literature. Previous studies have found that socially cohesive neighborhoods where there are strong social ties among residents support mental health among adolescents (Donnelly et al., 2016, Lowe et al., 2014; Solmi et al., 2017). A longitudinal study found that low social cohesion predicted higher odds of depressive symptoms at age 18 compared to adolescents living in highly cohesive neighborhoods (Solmi et al., 2017). Furthermore,

elevated neighborhood crime and lack of neighborhood safety have been related to increased psychological stress and depression for fear of exposure to violence (Assari & Caldwell, 2017). In addition, among a sample of inner-city adolescent African American and Caribbean youth, a higher risk of major depressive disorder was found among males who perceived their neighborhood as being unsafe (Assari & Caldwell, 2017).

Our findings indicated that the neighborhood structural environment is important to adolescent mental health. We found that neighborhood structural disadvantage was associated with adolescent depressive symptoms, but not in the moderation analysis. The association between neighborhood structural disadvantage and adolescent mental health has been found in other studies. The 'Moving to Opportunity' housing mobility intervention conducted among families in Baltimore, Boston, Chicago, Los Angeles, and New York showed that boys residing in poor neighborhoods had increased risk of depressive symptoms (Kessler et al., 2014). In addition, a longitudinal study conducted in Canada found that living in poor disadvantaged neighborhoods predicted suicidal thoughts as well as suicide attempts in late adolescence (Dupéré, Leventhal, & Lacourse, 2009).

Limitations

These findings must be considered with caution in light of the study limitations. One limitation was our reliance on self-ratings of depressive symptoms, and we could not control for family history of depression because that information was not in the dataset. Moreover, due to the cross-sectional nature of the study, we cannot draw causal conclusions about the relationship between neighborhood structural disadvantage and adolescent depressive symptoms; nor were we able to assess mediation. It must be noted

that we cannot rule out same-source bias; adolescents with depressive symptoms may have assessed their neighborhoods more negatively (Roux, 2007). Selection and non-response bias could have influenced our results. Non-response bias was addressed using multiple imputation. Although every effort was made to ensure that all participants' addresses were geocoded, not every residence could be geocoded. Furthermore, defining a neighborhood by census tract may not have been the same as what participants perceived the boundary of their neighborhood is. Length of residence was not considered in the analysis. Other networks (e.g., peer groups) were also not considered due to our focus on perceptions of the neighborhood social environment. Perceived neighborhood social cohesion had a low Cronbach's alpha for the study sample. Lastly, the data were collected in 1994–1995 and may not necessarily be representative of the present adolescent population.

Practical implications

Neighborhood structural disadvantage and neighborhood perceptions of social cohesion could serve as targets for the development of intervention strategies aimed at reducing depression, which has been suggested in the literature (Ahern & Galea, 2011; Fullerton et al., 2015). Ultimately, addressing neighborhood structural disadvantage and improving perceived neighborhood social cohesion along with perceived neighborhood safety, may help to reduce depressive symptoms and increase mental health service utilization among adolescents and subsequently depression risk and prevalence, thereby reducing the growing mental health burden among youth (Fleury, Ngui, Bamvita, Grenier, & Caron, 2014; Mmari, Marshall, Hsu, Shon, & Eguavoen, 2016).

Conclusions

This current study helps to advance the understanding of the associations between neighborhood processes and adolescent depressive symptoms. However, further studies are needed to validate our findings. Future studies should be conducted in other adolescent populations and use more recent available data. Even so, our study findings could help in the identification of neighborhood characteristics that impact depression among adolescents in the U.S. to advise the development of multilevel interventions. Perceived neighborhood social cohesion may be targeted in an intervention and thus increased by providing residents opportunities to engage in community activities that build social ties, solidarity, and trust (Chung et al., 2009). The neighborhood social environment may be more feasible as a multilevel intervention target than that of the structural environment due to the complexity of addressing such an aspect.

Furthermore, the influence of neighborhood perceptions varied suggesting a need to modify interventions based on varying levels of neighborhood structural disadvantage. Even so, interventions aimed at increasing perceived neighborhood social cohesion for mental illness prevention have been found to be promising (Chung et al., 2009), and a randomized-controlled trial aimed at changing the neighborhood structural environment of participants was found to decrease depressive symptoms (Kling, Liebman, Katz, 2007; Leventhal & Brooks-Gunn, 2003). Even the reduction of low depressive symptoms among adolescents might help to prevent the progression of clinical depression since subclinical levels of depressive symptoms are associated with impaired functioning (Rodríguez, Nuevo, Chatterji, & Ayuso-Mateos, 2012). In addition, interventions with social cohesion as a target have been successful for other health outcomes such as

HIV/AIDS and STDs (Bell et al., 2008; Carlson, Brennan, & Earls, 2012), suggesting that social cohesion is a malleable and potentially promising target for depression prevention interventions.

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Tables and figures

Table 1
National Longitudinal Study of Adolescent to Adult Health (Add Health) sample characteristcs, 1994–1995 (N=12,105)*[ł]

	Median (IQR) or N (%)	Range
Individual characteristics		
Age	16.0 (3)	11–21
Gender		
Male	5780 (47.8)	
Female	6324 (52.3)	
Race/ethnicity		
White, Non-Hispanic	7423 (61.4)	
Other, Non-Hispanic	128 (1.1)	
Native American or American Indian, Non-Hispanic	251 (2.1)	
Asian or Pacific Islander, Non-Hispanic	508 (4.2)	
Black or African American, Non-Hispanic	2328 (19.3)	
Hispanic	1457 (12.1)	
Parent education[a]		
College graduate	4023 (34.3)	
Some college	1588 (13.5)	
High school graduate	4354 (37.1)	
Less than high school	1774 (15.1)	
Parent occupation[b]		
Professional/mangerial	1790 (15.2)	
Other professional[c]	2177 (18.5)	
Sales, service, administration	2867 (24.3)	
Manual/blue collar	1448 (12.3)	
Other (unspecified)	2716 (23.0)	
Not working	800 (6.8)	
Family income, in thousands of dollars	40.0 (39.0)	0–999
Family structure		
Two parents	7809 (64.9)	
One parent	3530 (29.3)	
Other	701 (5.8)	
Perceived neighborhood social cohesion	6.0 (1)	1-6
Perceived neighborhood safety		
No	1225 (10.2)	
Yes	10793 (89.8)	
Depressive symptoms	10.0 (10)	0–54
Neighborhood characteristic		

Neighborhood structural disadvantage index		
Quartile 1 (least)	2.15 (1.92)	0.72–14.56
Quartile 2	-0.16 (0.70)	-0.65–0.72
Quartile 3	-1.04 (0.25)	-1.28–(-0.65)
Quartile 4 (most)	-1.52 (0.35)	-2.30–(-1.28)

*Totals and percentages may not add up to the total sample size and 100, respectively, due to missing data and rounding

[t]Due to rounding, values displayed may be zero

IQR=interqaurtile range

[a]The highest educational level for either parent was used as the value for the variable as reported by the adolescent.

[b]The highest occupation of either parent was used as the value for the variable as reported by the adolescent.

[c]Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations

Table 2
Bivariate associations between depressive symptoms and neighborhood perceptions and structural disadvantage

	Spearman ρ coefficient or Kruskal-Wallis x^2	p-value
Perceived neighborhood social cohesion	-0.10	≤0.001
Perceived neighborhood safety	291.46	≤0.001
Neighborhood structural disadvantage index quartiles	97.96	≤0.001

Table 3
Beta coefficients from mixed effects multilevel models testing the interactions between neighborhood perceptions and neighborhood structural disadvantage on depressive symptoms€‡*

	Model 1		Model 2		Model 3		Model 4	
Random effect	β Estimate	SE	β Estimate	SE	β Estimate	SE	β Estimate	SE
Intercept	0.05***	0.01	0.01**	0.00	0.01**	0.00	0.01**	0.00
Fixed effects								
Individual characteristics								
Age			0.45***	0.05	0.45***	0.05	0.44***	0.05
Gender								
Male			-	-	-	-	-	-
Female			0.23***	0.02	0.23***	0.02	0.23***	0.02
Race/ethnicity								
White, Non-Hispanic			-	-	-	-	-	-
Other, Non-Hispanic			0.03	0.10	0.03	0.10	0.02	0.10
Native American or American Indian, Non-Hispanic			0.24**	0.07	0.25**	0.07	0.25**	0.07
Asian or Pacific Islander, Non-Hispanic			0.34***	0.05	0.33***	0.05	0.33***	0.05
Black or African American, Non-Hispanic			0.10**	0.03	0.11***	0.03	0.11**	0.03
Hispanic			0.12***	0.04	0.13***	0.04	0.13***	0.04
Parent education[a]								
College graduate			-	-	-	-	-	-
Some college			0.02	0.04	0.02	0.04	0.02	0.04
High school graduate			0.19***	0.03	0.19***	0.03	0.19***	0.03
Less than high school			0.39***	0.04	0.40***	0.04	0.40***	0.04
Parent occupation[b]								
Professional/mangerial			-	-	-	-	-	-
Other professional[c]			0.02	0.04	0.02	0.04	0.02	0.04
Sales, service, administration			0.09*	0.04	0.09*	0.04	0.09*	0.04
Manual/blue collar			0.15***	0.04	0.16***	0.04	0.16***	0.04
Other (unspecified)			0.09**	0.04	0.10**	0.04	0.10**	0.04
Not working			0.05	0.06	0.06	0.06	0.06	0.06

Family income, in thousands of dollars	-0.01*	0.01	-0.01*	0.01	-0.01*	0.01
Family structure						
Two parents	-	-	-	-	-	-
One parent	0.12***	0.03	0.12***	0.03	0.12***	0.03
Other	0.21***	0.05	0.21***	0.05	0.21***	0.05
Perceived neighborhood social cohesion	-0.24***	0.04	-0.24***	0.04	-0.11	0.10
Perceived neighborhood safety						
No	-	-	-	-	-	-
Yes	-0.46***	0.04	-0.47***	0.04	-0.46***	0.06
Neighborhood characteristic						
Neighborhood structural disadvantage index						
Quartile 1 (least)			-	-	-	-
Quartile 2			0.03	0.04	-0.08	0.29
Quartile 3			0.03	0.04	0.41	0.30
Quartile 4 (most)			0.04	0.04	1.03***	0.30
Interaction terms						
Neighborhood structural disadvantage index x perceived neighborhood social cohesion					0.14***	0.04
Neighborhood structural disadvantage index x perceived neighborhood safety					0.03	0.03

*p<0.05
**p≤0.01
***p≤0.001
SE=standard error
[a]The highest educational level for either parent was used as the value for the variable as reported by the adolescent.
[b]The highest occupation of either parent was used as the value for the variable as reported by the adolescent.
[c]Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations
[€]Multiple imputation was used to deal with missing data
[ł]Due to rounding, values displayed may be zero
*All analyses were conducted on transformed data

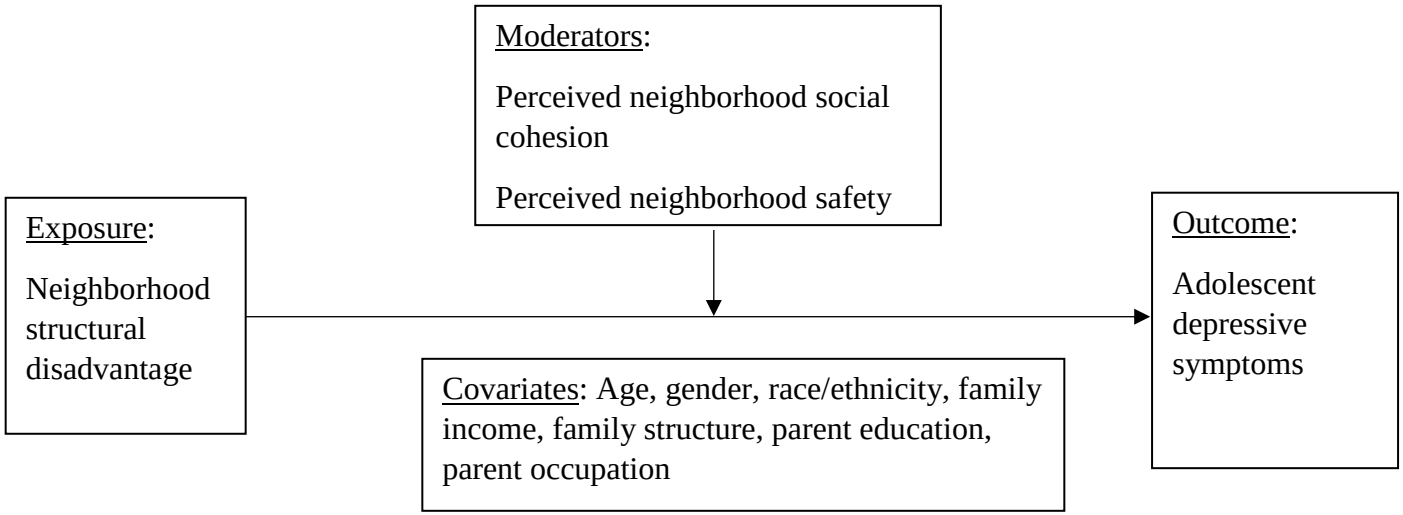
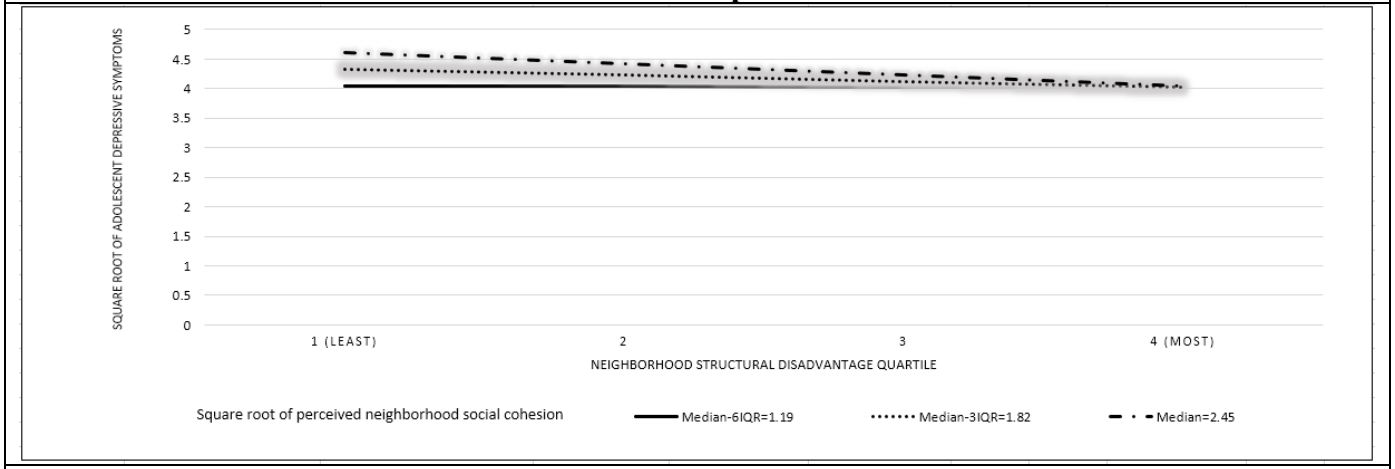


Figure 1. Adapted theoretical framework from Hill & Maimon (2013) linking neighborhood structural disadvantage and adolescent depressive symptoms

Neighborhood structural disadvantage and perceived neighborhood social cohesion interaction for full sample



	β Estimate	SE
Square root of perceived neighborhood social cohesion		
Median-6IQR	-0.05	0.07
Median-3IQR	-0.13*	0.06
Median	-0.22**	0.07

Figure 2a. Interaction graph and conditional estimates of neighborhood structural disadvantage on depressive symptoms by levels of the square root of perceived neighborhood social cohesion for the full sample. *Note:* Conditional beta (β) estimates were calculated adjusted for covariates and interactions from Table 3 Model 4 and for the square root of perceived neighborhood social cohesion at the median=2.45, median-3IQR=1.82, and median-6IQR=1.19. Values of the square root of adolescent depressive symptom scores are at the median values depicted. Bold *SE* is standard error. Highlighted graph lines denote significance. Significance values: *p<0.05, **p≤0.01

Appendix A

Sensitivity analysis beta coefficients from mixed effects multilevel models testing the interactions between neighborhood perceptions and neighborhood structural disadvantage on depressive symptoms€1*

	Model 1		Model 2		Model 3		Model 4	
Random effect	β Estimate	SE	β Estimate	SE	β Estimate	SE	β Estimate	SE
Intercept	0.02***	0.00	0.01*	0.00	0.01*	0.00	0.01*	0.00
Fixed effects								
Individual characteristics								
Age			0.26***	0.04	0.26***	0.04	0.26***	0.04
Gender								
Male			-	-	-	-	-	-
Female			0.06***	0.02	0.06***	0.02	0.06***	0.02
Race/ethnicity								
White, Non-Hispanic			-	-	-	-	-	-
Other, Non-Hispanic			0.08	0.09	0.08	0.09	0.08	0.09
Native American or American Indian, Non-Hispanic			0.11	0.07	0.12	0.07	0.11	0.07
Asian or Pacific Islander, Non-Hispanic			0.24***	0.05	0.24***	0.05	0.24***	0.05
Black or African American, Non-Hispanic			0.09***	0.03	0.10***	0.03	0.10**	0.03
Hispanic			0.08**	0.03	0.09**	0.03	0.09**	0.03
Parent education[a]								
College graduate			-	-	-	-	-	-
Some college			0.02	0.03	0.01	0.03	0.02	0.03
High school graduate			0.11***	0.02	0.11***	0.02	0.11***	0.02
Less than high school			0.25***	0.04	0.25***	0.04	0.25***	0.04
Parent occupation[b]								
Professional/mangerial			-	-	-	-	-	-
Other professional[c]			0.02	0.03	0.02	0.03	0.02	0.03
Sales, service, administration			0.09**	0.03	0.09**	0.03	0.09**	0.03
Manual/blue collar			0.14***	0.04	0.14***	0.04	0.14***	0.04
Other (unspecified)			0.08*	0.03	0.08*	0.03	0.08*	0.03

Not working	-0.02	0.05	-0.02	0.05	-0.02	0.05
Family income, in thousands of dollars	-0.01*	0.00	-0.01*	0.00	-0.01*	0.00
Family structure						
Two parents	-	-	-	-	-	-
One parent	0.05	0.02	0.05	0.02	0.04	0.02
Other	0.09*	0.05	0.09*	0.05	0.09	0.05
Perceived neighborhood social cohesion	-0.14***	0.04	-0.14***	0.04	-0.03	0.09
Perceived neighborhood safety						
No	-	-	-	-	-	-
Yes	-0.20***	0.03	-0.21***	0.03	-0.20***	0.05
Neighborhood characteristic						
Neighborhood structural disadvantage index						
Quartile 1 (least)			-	-	-	-
Quartile 2			0.02	0.03	0.05	0.27
Quartile 3			0.03	0.03	0.29	0.27
Quartile 4 (most)			0.01	0.03	0.74**	0.27
Interaction terms						
Neighborhood structural disadvantage index x perceived neighborhood social cohesion					0.10**	0.04
Neighborhood structural disadvantage index x perceived neighborhood safety					0.02	0.03

*p<0.05
**p≤0.01
***p≤0.001
SE=standard error
[a]The highest educational level for either parent was used as the value for the variable as reported by the adolescent.
[b]The highest occupation of either parent was used as the value for the variable as reported by the adolescent.
[c]Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations
[€]Multiple imputation was used to deal with missing data
[ŧ]Due to rounding, values displayed may be zero

*All analyses were conducted on transformed data

MANUSCRIPT 3

Effects of neighborhood disadvantage and perceptions on depressive symptom trajectories from adolescence to young adulthood

Abstract

Aims: There is a dearth of research regarding the effects of the neighborhood environment on depressive symptoms from adolescence to adulthood. This study investigated the effects of neighborhood structural disadvantage on depressive symptom trajectories as well as the moderating role of neighborhood perceptions on the relationship during adolescence and young adulthood. **Methods:** Data were drawn from the National Longitudinal Study of Adolescent to Adult Health (Add Health). Growth curve modeling was conducted using three waves of data spanning 18 years which included 12,105 adolescents at baseline. **Results:** Neighborhood perceptions, but not neighborhood structural disadvantage, were found to affect depressive symptom trajectories. A significant interaction between concentrated poverty, one component of neighborhood structural disadvantage, and neighborhood perceptions was found. **Conclusion:** Findings suggest that improving neighborhood collective efficacy, contentment, and safety may decrease depressive symptoms of adolescents as they transition into young adulthood, particularly in neighborhoods with high poverty. These aspects of the neighborhood social environment may serve as targets for structural and other interventions such as community-level interventions as well as guide policy to prevent and reduce depression among adolescents, thereby ensuring healthy psychological development into adulthood.

Keywords: neighborhood structural disadvantage, neighborhood perceptions, social environment, depressive symptoms, adolescence, young adulthood

Introduction

Depression among adolescents is a major concern in the United States (U.S.) (Mojtabai, Olfson, & Han, 2016). There has been an increase in the number of adolescents that suffer from depression (Center for Behavioral Health Statistics and Quality, 2018). It is estimated that the prevalence of depression among 12 to 17 year-olds was 13.3% or 3.2 million in 2017 (Center for Behavioral Health Statistics and Quality, 2018; National Institute of Mental Health, 2019). This finding contrasted with a lower estimated prevalence observed in 2004–2012 among those 12–17 years old, which ranged from 7.9%–9.1% (Center for Behavioral Health Statistics and Quality, 2018). This apparent increase in prevalence is concerning because adolescents who are depressed are more likely to exhibit health risk behaviors and have poor health outcomes later in life, including sexual risk-taking (Jackson, Seth, DiClemente, & Lin, 2015), sexually transmitted infections (STIs) (Jackson, Seth, DiClemente, & Lin, 2015), obesity (Schwartz et al., 2016), comorbid psychiatric conditions such as suicide (Goldston et al., 2016; Thapar, Collishaw, Pine, & Thapar, 2012), substance use (Maslowsky, Schulenberg, & Zucker, 2014), and criminal behavior (Anderson, Cesur, & Tekin, 2015). In addition, subthreshold depressive symptoms are associated with impaired functioning (Wesselhoeft, Sørensen, Heiervang, & Bilenberg, 2013). The economic impact of depression can be seen in the increased expenditures for in- and out-patient care in the public health sector (Wright et al., 2016).

Neighborhood context and adolescent depression

Much of the research on depression among adolescents has focused on individual- and family-level predictors and correlates (Cairns, Yap, Pilkington, & Jorm, 2014). To better understand depression in this population, researchers have increasingly examined the contribution of the neighborhood environment to depression among adolescents. Aspects of the neighborhood environment that have been recently studied include neighborhood collective efficacy, safety, contentment and neighborhood structural disadvantage. *Collective efficacy* is defined as willingness of neighborhood residents to come together and to take action for the common good (Sampson, Raudenbush, & Earls, 1997). It consists of informal social control, which is the "ability of residents to induce public order and obtain resources for the community", and social cohesion, which involves "neighbors knowing, helping, and trusting each other" (Sampson, Raudenbush, & Earls, 1997). In contrast, *neighborhood structural disadvantage* refers to a lack of institutional, social and material resources (Hill & Maimon, 2013). Neighborhood structural disadvantage is conceptualized as having three components: concentrated poverty, which is the level of socio-economic deprivation; residential instability, which is the movement of individuals in and out of neighborhoods; and immigrant concentration, which is the proportion of foreign-born residents (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008).

Studies examining these factors have documented their influence on depressive symptoms and depression among adolescents. A longitudinal study conducted in Canada found that higher levels of social cohesion predicted adolescents having fewer depressive symptoms (Kingsbury et al., 2015). In addition, among a sample of urban Midwestern

African American adolescents, increased levels of social cohesion were correlated with lower levels of depressive symptoms (Hurd, Stoddard, & Zimmerman, 2013). In a sample of African American youth, those who perceived their neighborhoods as unsafe had higher odds of major depressive disorder (Assari & Caldwell, 2017). Furthermore, a study conducted in California found that adolescents who perceived their neighborhoods as unsafe were two times more likely than those who perceived their neighborhoods as safe to report serious psychological distress (Goldman-Mellor, Margerison-Zilko, Allen, & Cerda, 2016). For neighborhood contentment, no studies of adolescents were identified, but a study among adults found that lower neighborhood satisfaction was associated with poorer mental health (Kamimura et al., 2014).

Findings on the relationship between neighborhood structural disadvantage and depressive symptoms have been mixed (Simons et al., 2002; Xue, Leventhal, Brooks-Gunn, & Earls, 2005). A housing mobility intervention conducted among families in Baltimore, Boston, Chicago, Los Angeles, and New York, showed that boys residing in disadvantaged neighborhoods had increased risk of depressive symptoms (Kessler et al., 2014). Specifically, among African American adolescents, higher neighborhood disadvantage predicted greater internalizing symptoms (Hurd, Stoddard, & Zimmerman, 2013). However, another study among African American children did not find that neighborhood disadvantage was correlated with depressive symptoms (Simons et al., 2002). Neighborhood structural disadvantage was not associated with levels of depression severity among 5–11year olds in Chicago after full adjustment for other covariates (Xue, Leventhal, Brooks-Gunn, & Earls, 2005).

Theoretical framework

The proposed study was guided by the Ecological Systems Theory of Human Development (Bronfenbrenner, 1994) and the theoretical framework linking neighborhoods to mental health outcomes, specifically depression, by Hill and Maimon (2013). These two theories were integrated due to their focus on youth development and neighborhood influence on mental health. The Ecological Systems Theory of Human Development posits that child development is influenced by the interaction between the individual and his/her environment. The environment can be divided into various subsystems including the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. For the purposes of our study, only the exosystem, which consists of the neighborhood-community context, was examined. The exosystem contains events that influence processes within the immediate environment in which a developing person lives. As individuals transition from adolescence to young adulthood, there is generally a reduction in depressive symptoms (Mojtabai, Olfson, & Han, 2016). Individuals move from high school to higher education and/or the workforce, gaining more autonomy from families (Steinberg, 2017). Neighborhood processes can influence the psychological development of an adolescent as they become adults in a positive or negative way, thereby impacting mental health. A theoretical framework proposed by Hill and Maimon (2013), helps elucidate the relationship between the neighborhood environment and depression. With its origins in social disorganization theory and grounded by empirical evidence, the framework shows how neighborhood structural disadvantage may influence depression trajectories itself but can be impacted by individual characteristics, such as

perceptions of the neighborhood (Hill & Maimon, 2013). The theoretical framework shown in Figure 1 shows the adaptation of the theoretical framework by Hill and Maimon (2013) for the proposed study, which focuses solely on adolescents.

The current study

The manner in which neighborhood structural disadvantage may exert its influence on depression is poorly understood, and there have been calls to examine potential pathways (Blair, Ross, Gariepy, & Schmitz, 2014). Most of the studies on neighborhood structural disadvantage, collective efficacy, and safety have focused on adults or young children (i.e., not adolescents). Additionally, studies were limited by cross-sectional designs and samples that were small, geographically restricted, and lacked racial/ethnic diversity. The studies on adolescents were conducted either outside the U.S. (i.e., Canada) or focused on U.S. subpopulations (i.e., African Americans) in select parts of the country such as Iowa and Georgia. No studies have yet examined the effects of neighborhood collective efficacy, contentment, safety and neighborhood structural disadvantage on depressive symptoms among a representative sample of U.S. adolescents, particularly over time. A better understanding of the putative effects of neighborhood perceptions and structural disadvantage on depression is needed to develop effective interventions. Therefore, the objective of the current study was to examine the relationship between trajectories in depressive symptoms and neighborhood structural disadvantage; and the moderating role of perceived neighborhood collective efficacy on this relationship among a diverse, nationally representative sample of adolescents in the U.S. In addition, we explored how other neighborhood perceptions (i.e. contentment and safety) may act as moderators.

Hypotheses

We hypothesized that decreasing levels of neighborhood structural disadvantage would lead to lower levels of depressive symptoms and that neighborhood perceptions would attenuate the effect of neighborhood structural disadvantage on depressive symptoms among U.S. adolescents over time. That is, increases in perceived neighborhood collective efficacy, contentment, and safety would weaken the relationship between neighborhood structural disadvantage and depressive symptoms. The proposed study has several advantages over past studies including (a) a relatively large sample size, (b) use of longitudinal analyses, and (c) a racially/ethnically diverse, national sample of adolescents across the U.S.

Methods

Data came from the National Longitudinal Study of Adolescent to Adult Health (Add Health) core sample (N=12,105) (Harris, 2009). Add Health is a nationally, representative study designed to determine the developmental trajectories of adolescence into adulthood. Data from Wave I (1994-1995; N=12,105), Wave II (1996; N=9,142), and Wave III (2008; N=9,131) were utilized. Schools were sampled based on region, urbanicity, size, type, and ethnicity composition of the target population (Chen & Chantala, 2014). For a school to be eligible, it had to include an 11th grade and have more than 30 enrolled students. Students who completed the in-school questionnaire and students who did not complete the in-school questionnaire but were still on the school roster were eligible for selection. Students were stratified by grade and sex. About 17 students were randomly chosen from each stratum so that about 200 adolescents were selected from each of the 80 pairs of schools. Data were collected with an in-home

questionnaire at the respondent's home using computer-assisted personal interviewing (CAPI) and computer-assisted self-interviewing (CASI). Parents of the core sample were asked to complete a parent questionnaire. The mother or other female head of household was the preferred respondent. This is because results from previous studies have shown that mothers are more aware than fathers of their child's schooling, health behaviors, and health status (Crouter & Head, 2002; de Castro Ribas Jr. & Bornstein, 2005; Keijsers, Branje, VanderValk, & Meeus, 2010). Interviews took about 1 to 2 hours to complete. A detailed description of the Add Health methodology can be found elsewhere (Harris, 2011; Harris, 2013). Local Institutional Review Board (IRB) approval was obtained prior to conducting the study at Florida International University.

Measures

Depressive symptoms. Depressive symptoms were assessed using 9 out of the 20 items from the Center for Epidemiologic Studies Depression Scale (CES-D) used in Add Health. Since growth curve modeling dictates the use of equivalent measures over time points, particularly for the outcome, the same 9 items from the CES-D scale that were used to evaluate depressive symptoms at each wave were used (Meadows, Brown, & Elder, 2006; McPhie & Rawana, 2015). The 9 CES-D items have been found to have acceptable internal consistency (Cronbach's alpha=0.77–0.82) across all 3 waves (McPhie & Rawana, 2015). The items include the following: "You were bothered by things that don't usually bother you," "You felt you were just as good as other people," "You were happy," "You talked less than usual," "You felt sad," "You felt that people disliked you," "It was hard to get started doing things," and "You felt life was not worth living." For each item, respondents had to choose how often each statement was true in

the past week. Respondents could choose “never or rarely”, “sometimes”, “a lot of the time”, “most of the time” or “all the time.” To obtain a depressive symptoms score, items were summed while taking into consideration reverse coding. The depressive symptoms score was treated as a continuous variable. Each item was considered a depressive symptom and higher scores indicated higher levels of depressive symptoms.

Neighborhood structural disadvantage. Neighborhood structural disadvantage consisted of the following components: concentrated poverty, residential instability, and immigrant concentration (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008). Each component was assessed at the census tract level taken from the Add Health Contextual I database at Wave I, Wave II, and Wave III. Neighborhoods were defined as census tracts. Scores for each construct of neighborhood structural disadvantage were obtained by conducting principal component analysis. The first component was concentrated poverty, which consisted of percent receiving public assistance, percent unemployed, percent female headed households, and percent living below the poverty line. The second component was residential instability, which included percent living in the same house since 1985 and percent houses occupied by owners. The third component was immigrant concentration, which consisted of percent Latino/Hispanic and percent foreign-born. Factor loadings from each principal component were used as weights to construct a score for each census tract (or neighborhood) at each wave of data collection. All values were standardized with a mean of zero and a standard deviation of one prior to conducting principal component analysis due to differences in units of measurement (Ringnér, 2008).

Neighborhood perceptions. Perceptions of the neighborhood environment assessed were collective efficacy, contentment, and safety at Wave I and II by adolescent respondents. Perceived neighborhood collective efficacy as measured by social cohesion was assessed by respondents indicating if the following 3 items were true: "In the past month, you have stopped on the street to talk with someone who lives in your neighborhood," "You know most of the people in your neighborhood," and "People in this neighborhood look out for each other." Items were summed while taking into consideration reverse coding with higher scores indicating higher levels of perceived neighborhood collective efficacy. The items used to compute the total score have been found to have moderate internal consistency (Cronbach's alpha=0.60) (Donnelly, 2015). Perceived neighborhood contentment was assessed with the a 5-point Likert item, "On the whole, how happy are you with living in your neighborhood?" It was treated as a continuous variable with higher scores indicating higher levels of perceived neighborhood contentment. Perceived neighborhood safety was assessed with the following 1 item, "Do you usually feel safe in your neighborhood?" It was treated as a dichotomized categorical variable coded as "no" and "yes."

Covariates. Age, gender, race/ethnicity, family structure, family income, parent occupation, and parent education were adjusted for in the analysis. Age was assessed as a continuous measure reported by the adolescent at each wave. Gender was assessed as the participants' biological sex at birth. It was treated as a dichotomized variable coded as male or female. Race/ethnicity was assessed as a categorical variable and coded as non-Hispanic White, Hispanic, and other non-Hispanic. Family structure was assessed at Wave I and Wave II as a categorical variable coded as two-parent, one-parent, and other

structured household. Family income was assessed as a continuous variable and reported by the parent in thousands of dollars as the total amount of income, before taxes, the family received in 1994 at Wave I. At Wave III family income was reported by the respondent in thousands of dollars as the total amount of income, before taxes, the respondent's household received in 2000/2001. Occupation was assessed as a categorical variable reported by the adolescent for each parent [professional/managerial, other professional, which included community/social services, education/training/library, and arts/design/entertainment/sports/media occupations; sales, service, and administration; manual/blue collar, other (unspecified), and not working] at Wave I and Wave II. The highest occupation from either parent was used as the value for the variable. At Wave III, occupation was assessed for and by the respondent. Education was taken as a categorical variable reported by the adolescent for each parent at Wave I and Wave II. It was coded as college graduate, some college, high school graduate, and less than high school. The highest educational level for either parent was used as the value for the variable. At Wave III, education was assessed for and by the respondent using the highest level of education obtained.

Analytic strategy

Due to the non-normality of the data, descriptive statistics included medians and interquartile ranges for continuous variables as well as counts and percentages for categorical variables. Bivariate analyses were conducted at Wave I, Wave II, and Wave III to determine the association between neighborhood structural disadvantage components (i.e. concentrated poverty, residential instability, and immigrant concentration), neighborhood perceptions, and demographic characteristics with

adolescent depressive symptoms. The non-parametric tests Spearman's correlation for continuous variables and Kruskal-Wallis for categorical variables were performed. Correlations and chi-square statistics along with p-values are reported.

Random effects growth curve modeling was used to estimate the role of neighborhood structural disadvantage on levels of depressive symptoms among adolescents across Waves I, II, and III. Specifically, we examined the change in trajectories in depressive symptoms and neighborhood structural disadvantage index separately across Waves I, II, and III. Then we examined the change in trajectories for the relationship between depressive symptoms and neighborhood structural disadvantage across Waves I, II, and III. Models were fitted in stages with individual variables entered first followed by neighborhood variables. Interactions were included in separate models to determine if neighborhood perceptions moderated the relationship between neighborhood structural disadvantage and depressive symptoms. Estimates obtained included descriptive statistics, specifically means and standard deviations for continuous variables and counts and percentages for categorical variables, and parameter estimates with standard errors and p-values. The changes in depressive symptoms relative to changes in neighborhood structural disadvantage were graphed for ease of interpretation.

Maximum likelihood estimation method with robust standard errors was used to handle missing data and to account for the non-normality of the data. Maximum likelihood estimation is a procedure that uses all available data (complete and incomplete) to identify parameter values that have the highest probability to produce the data by calculating the likelihood function (Baraldi & Enders, 2010). Maximum likelihood is preferable to other methods of handling missing data because it produces

estimates that are consistent (i.e. unbiased), asymptotically efficient (i.e. have minimal standard errors), and asymptotically normal (i.e. can use normal approximation to calculate confidence intervals and p-values) (Allison, 2009; Allison, 2012). All analyses were conducted using SAS for Windows version 9.4 statistical software and Mplus version 7.4 (Muthén & Muthén, 1998–2017; SAS Institute, 2013).

Results

Demographics

The median age of the study sample at Wave I was 16.0 years [interquartile range (IQR)=3.0] (Table 1). The majority of participants was non-Hispanic white (61.4%), female (52.3%), and came from a two-parent family household (64.9%). The median perceived neighborhood collective efficacy score was 6.0 (IQR=1.0), and the median perceived neighborhood contentment score was 4.0 (IQR=2.0). A high proportion (89.8%) of adolescents perceived their neighborhood as being safe. Adolescent depressive symptom scores were in the mild range (median=5.0, IQR=5.0). Additional sample characteristics including individual and neighborhood level for Wave I, Wave II, and Wave III can be found in Table 1.

Bivariate associations

The table in Appendix A shows the bivariate associations between variables of interest at Wave I, Wave II, and Wave III. Depressive symptoms scores were significantly associated with all neighborhood perception variables at Wave I (perceived neighborhood social cohesion: r=-0.09, $p \leq 0.001$; perceived neighborhood contentment: r=-0.22, $p \leq 0.001$; perceived neighborhood safety: $x^2=243.43$, $p \leq 0.001$) and Wave II (perceived neighborhood social cohesion: r=-0.10, $p \leq 0.001$; perceived neighborhood

contentment: r=-0.24, p ≤0.001; perceived neighborhood safety: x^2=204.18, p ≤0.001). As previously mentioned, bivariate associations between depressive symptoms and neighborhood perceptions could not be determined at Wave III since they were not assessed. For neighborhood structural disadvantage, concentrated poverty was positively associated with depressive symptoms at Wave I (r=0.11, p ≤0.001), Wave II (r=0.11, p ≤0.001), and Wave III (r=0.04, p ≤0.001). Residential instability (r=-0.04, p ≤0.001) was negatively associated with depressive symptoms at Wave III only. Immigrant concentration was not associated with depressive symptoms at any wave.

Temporal changes in depressive symptoms and neighborhood structural disadvantage

The change in depressive symptoms followed a growth curve as shown in Figure 2a, with an intercept of 5.976 (SE=0.045, p ≤0.001; see Table 2) with the rate of change decreasing over time for the entire sample (slope=-0.791, SE=0.028, p ≤0.001; see Table 2). For neighborhood structural disadvantage, the intercepts for neighborhood concentrated poverty and residential instability were -0.153 (SE=0.019, p ≤0.001; see Table 2) and -0.093 (SE=0.011, p ≤0.001; see Table 2), respectively. Concentrated poverty (slope=0.033, SE=0.005, p ≤0.001; see Figure 2b and Table 2) increased over time among participants from Wave I to Wave III. In contrast, the intercept for neighborhood immigrant concentration was 0.263 (SE=0.012, p ≤0.001; see Table 2) and decreasing (slope=-0.030, SE=0.002, p ≤0.001; see Figure 2b and Table 2) for the full sample from adolescence to adulthood. There was no significant change in residential instability.

Effects of neighborhood structural disadvantage and perceptions on depression trajectories

Table 3 displays beta coefficients from the fully adjusted growth curve analysis examining the effect of neighborhood structural disadvantage and perceptions on depressive symptoms from adolescence to young adulthood. Perceived neighborhood collective efficacy was associated with decreases in depressive symptoms at Wave I and Wave II. At Wave I, each unit increase in perceived neighborhood collective efficacy was associated with a 0.063 (SE=0.037) decrease in depressive symptoms. Each unit increase in perceived neighborhood collective efficacy at Wave II was associated with a 0.118 (SE=0.043) decrease in depressive symptoms. The decrease was not significant at Wave I ($p > 0.05$) but was significant at Wave II ($p \leq 0.01$). Perceived neighborhood contentment was significantly associated with a decrease in depressive symptoms ($p \leq 0.001$). Each unit increase in perceived neighborhood contentment was associated with a 0.643 (SE=0.040) and 0.593 (SE=0.046) decrease in depressive symptoms at Wave I and Wave II, respectively. Perceived neighborhood safety was significantly associated with a reduction in depressive symptoms ($p \leq 0.001$). Those who perceived their neighborhood as safe had a 0.630 (SE=0.145) and 0.529 (SE=0.170) decrease in depressive symptoms compared to those who did not perceive their neighborhood as safe at Wave I and Wave II, respectively. For neighborhood structural disadvantage, concentrated poverty, residential instability, and immigrant concentration did not affect depressive symptoms at Wave I, Wave II, or Wave III ($p > 0.05$).

Moderation by neighborhood perceptions on depression trajectories

Interaction effects of neighborhood perceptions on the relationship between neighborhood structural disadvantage and depressive symptoms are shown in Appendix B. For perceived neighborhood collective efficacy, significant moderation was found only at Wave I for concentrated poverty (β=-0.074, SE=0.020, p ≤0.001). A 1 unit increase in perceived neighborhood collective efficacy attenuated the effect of concentrated poverty on depressive symptoms by 0.046 (SE=0.038). Perceived neighborhood contentment significantly moderated the association between concentrated poverty and depressive symptoms at Wave I (β=-0.074, SE=0.018, p ≤0.001) and Wave II (β=-0.083, SE=0.021, p ≤0.001). A 1 unit increase in perceived neighborhood contentment attenuated the association between concentrated poverty and depressive symptoms by 0.659 (SE=0.041) and 0.588 (SE=0.048) at Wave I and Wave II, respectively. Perceived neighborhood safety significantly moderated the association between concentrated poverty and depressive symptoms at Wave II only (β=-0.148, SE=0.071, p <0.05). For those who perceived their neighborhood as being safe, perceived neighborhood safety attenuated the effect of concentrated poverty on depressive symptoms by 0.626 (SE=0.180) at Wave II compared to those who did not perceive their neighborhood as safe.

Discussion

To our knowledge, this is the first study that has conducted an examination of the relationship between neighborhood structural disadvantage, neighborhood perceptions, and depressive symptoms from adolescence to young adulthood. Utilizing a nationally representative sample of adolescents, we investigated trajectories of depressive symptoms

and neighborhood structural disadvantage as well as potential moderating factors that may mitigate the effects of living in a disadvantaged neighborhood on depressive symptoms. We found that higher levels of perceived neighborhood collective efficacy, contentment, and perceiving one's neighborhood as safe were associated with lower levels of depressive symptoms. No aspect of neighborhood structural disadvantage was associated with depressive symptoms alone. However, interactions between neighborhood concentrated poverty and neighborhood perceptions led to lower levels of depressive symptoms. Thus, our hypotheses were partially supported. Our findings extend the knowledge of how neighborhood structural disadvantage and social environment of communities influence depressive symptom trajectories from adolescence to young adulthood.

The finding that perceptions of the neighborhood social environment affect adolescent depressive symptoms are consistent with the existing literature. Previous studies have found that socially cohesive neighborhoods with strong social ties among residents support mental health among adolescents (Donnelly et al., 2016; Lowe et al., 2014; Solmi, Colman, Weeks, Lewis, & Kirkbride, 2017). A longitudinal study among adolescents found that low social cohesion predicted higher odds of depressive symptoms at age 18 compared to adolescents living in highly cohesive neighborhoods (Solmi, Colman, Weeks, Lewis, & Kirkbride, 2017). Furthermore, elevated neighborhood crime and lack of neighborhood safety have been related to increased psychological stress and depression for fear of exposure to violence (Assari & Caldwell, 2017). Among a sample of inner-city adolescent African American and Caribbean youth, a higher risk of major depressive disorder was found among males who perceived their neighborhood as being

unsafe (Assari & Caldwell, 2017). Our study is the only one to our knowledge that has found that higher neighborhood contentment is associated with lower depressive symptoms among adolescents.

We found that only concentrated poverty affected depressive symptoms, while residential instability and immigrant concentration did not. Previous studies assessing the relationship between neighborhood structural disadvantage and adolescent depressive symptoms have been conflicting as some studies have found support of an association while others have not depending on the aspect of structural disadvantage examined. Studies examining the influence of concentrated poverty on adolescent mental health have consistently found an association between neighborhood poverty and depression. The 'Moving to Opportunity' housing mobility intervention conducted among families in Baltimore, Boston, Chicago, Los Angeles, and New York showed that boys residing in high poverty areas had increased risk of depressive symptoms (Kessler et al., 2014). In addition, a longitudinal study conducted in Canada found that living in poor neighborhoods predicted suicidal thoughts and attempts in late adolescence (Dupéré, Leventhal, & Lacourse, 2009). However, studies examining the association between residential instability and immigrant concentration and adolescent depressive symptoms have been inconsistent (Gilman, Kawachi, Fitzmaurice, & Buka, 2003; Lewis et al., 2015; Maimon, Browning, & Brooks-Gunn, 2010). This inconsistency may be partly attributed to the fact that certain areas with high concentrations of immigrants or ethnic enclaves may be conducive to better mental health among foreign-born adolescents (Wight, Aneshensel, Botticello, & Sepúlveda, 2005). In addition, not taking into account different types of residential instability may have resulted in not finding an association

(Burgard, Seefeldt, & Zelner, 2012). Previous research indicates that varying types of residential instability may have different influences on mental health such as being homeless and being evicted compared to "doubling up," which can refer to two or more families sharing the same residence (Burgard, Seefeldt, & Zelner, 2012; Bush & Shinn, 2017).

The finding that perceived neighborhood collective efficacy, contentment, and safety moderated the relationship between concentrated poverty and adolescent depressive symptoms stresses the importance of taking into account the neighborhood social environment along with the structural environment; concentrated poverty was not significantly related to depression until the interactions were included in the models. Moreover, the significance of the interactions varied by wave. Perceived neighborhood collective efficacy moderated the relationship between concentrated poverty and depressive symptoms at Wave I while perceived neighborhood safety moderated the same relationship at Wave II. Perceived neighborhood contentment moderated the relationship at Wave I and Wave II. This may indicate that at different periods of development the interplay between the social and structural aspects of neighborhoods on depressive symptoms varies, which may be plausible in theory. The Ecological Systems Theory of Human Development and Hill and Maimon's framework emphasizes the interaction between the developing adolescent and their environment, which may influence depression. As adolescents develop, the relative importance of certain characteristics of the neighborhood social environment may change resulting in differential moderation effects on the relationship between the structural environment and depression. Furthermore, our findings support our adaptation of Hill and Maimon's

(2013) theoretical framework. The results of our study partially support the predicted interactions between neighborhood structural disadvantage and neighborhood perceptions. The social environment may help to buffer against depressive symptoms, particularly among adolescents, even in relatively poor neighborhoods.

Limitations and strengths

Findings must be considered with caution in light of the study limitations. A limitation of the research is reliance on self-ratings of depression symptoms. Depressive symptoms were assessed using only 9 out of the 20 items from the CES-D scale since it is important when doing growth curve modeling that equivalent measures are used, especially for the outcome (Meadows, Brown, & Elder, 2006; McPhie & Rawana, 2015). Moreover, neighborhood perceptions were only assessed at Wave I and Wave II. We cannot rule out same-source bias since those with depressive symptoms may have assessed their neighborhoods more negatively (Roux, 2007). Although every effort was made to ensure that all participants' addresses were geocoded, not every residence could be geocoded. We were limited in examining no slope and linear slope models because we did not have enough waves to explore other patterns of growth such as quadratic models. The analysis chosen for the study was determined to be the most appropriate given our research objectives, including examining depression trajectories from adolescence to young adulthood. Furthermore, the data were collected in 1994–2008 and may not necessarily be representative of the present population. The study should be replicated in a more recent cohort since family structures, neighborhoods, and social norms may have changed over time. Despite these limitations, there are strengths to be noted in the study. The use of a longitudinal study design allowed us to draw conclusions about the temporal

relationships between neighborhood structural disadvantage, neighborhood perceptions, and depressive symptoms from adolescence to young adulthood. Maximum likelihood estimation with robust standard errors was used to address missing data and non-normality. Finally, Add Health is a nationally representative study of adolescents in the U.S. It is one of the largest and most comprehensive studies among this population.

Implications

Components of neighborhood structural disadvantage, specifically concentrated poverty, and neighborhood perceptions of collective efficacy, contentment, and safety could serve as targets for intervention strategies aimed at reducing or preventing depression (Ahern & Galea, 2011; Assari & Caldwell, 2017; Fullerton et al., 2015; Grogan-Kaylor et al., 2006). Perceived neighborhood collective efficacy may be targeted in an intervention and thus increased by providing residents opportunities to engage in community activities that build social ties, solidarity, and trust (Chung et al., 2009). Perceived neighborhood contentment may be targeted in a community by addressing factors that have been found to influence resident satisfaction such as safety from crime, cleanliness, access to recreational activities, and general appearance (Hur & Morrow-Jones, 2008). In addition, perceived neighborhood safety may be targeted by addressing resident concerns about crime, which may involve increasing neighborhood enforcement of laws and safe-ride programs (Assari & Caldwell, 2017; Kondo, Andreyeva, South, MacDonald, & Branas, 2018). The neighborhood social environment may be more feasible as multilevel intervention targets than those of structural environment due to the complexity of addressing such an aspect. Ultimately, addressing neighborhood structural disadvantage and improving collective efficacy along with neighborhood contentment

and neighborhood safety, may help to reduce depressive symptoms among adolescents and subsequently depression risk and prevalence, thereby reducing the growing mental health burden among youth.

Conclusions

This current study helps to advance the understanding of the relationship between neighborhood processes and adolescent depression. Findings could help in the identification of neighborhood characteristics that impact depression among adolescents in the U.S. to advise the development of multilevel interventions. Addressing neighborhood structural disadvantage and improving collective efficacy along with neighborhood contentment and neighborhood safety, may help to reduce depressive symptoms among adolescents and subsequently depression risk and prevalence, thereby reducing the growing mental health burden among youth.

Furthermore, the influence of neighborhood perceptions varied over time suggesting a need to modify multilevel interventions based on varying levels of structural disadvantage. Even so, interventions aimed at increasing collective efficacy for mental illness prevention have been found to be promising (Chung et al., 2009), and a randomized-control trial aimed at changing the neighborhood structural environment of participants was found to decrease depressive symptoms (Kling, Liebman, & Katz, 2007; Leventhal & Brooks-Gunn, 2003). In addition, interventions with collective efficacy as a target have been successful for other health outcomes such as HIV/AIDS and STDs (Bell et al., 2008; Carlson, Brennan, & Earls, 2012).

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Tables and figures

Table 1
Descriptive characteristics of study sample at Wave I (1994-1995), Wave II (1996), and Wave III (2008), Add Health*[f]

	Wave I[a] **N=12,105** [N (%) or Median (IQR)]	Range	**Wave II**[b] **N=9,142** [N (%) or Median (IQR)]	Range	**Wave III**[c] **N=9,131** [N (%) or Median (IQR)]	Range
Time-invariant						
Gender						
Male	5780 (47.8)					
Female	6324 (52.3)					
Race/ethnicity						
White, Non-Hispanic	7423 (61.4)					
Hispanic	1457 (12.1)					
Other, Non-Hispanic	3215 (26.6)					
Time-variant						
Age	16.0 (3.0)	11–21	16.0 (2.0)	12–21	22 (3.0)	18–28
Occupation						
Professional/mangerial	1790 (15.2)		545 (6.2)		1124 (14.0)	
Other professional[§]	2177 (18.5)		1017 (11.5)		1033 (12.8)	
Sales, service, administration	2867 (24.3)		2224 (25.2)		1697 (21.1)	
Manual/blue collar	1448 (12.3)		1595 (18.1)		1311 (16.3)	
Other (unspecified)	2716 (23.0)		1395 (15.8)			
Not working	800 (6.8)		2063 (23.3)		2887 (35.9)	
Education						
College graduate	4023 (34.3)		407 (23.4)		1167 (12.8)	
Some college	1588 (13.5)		717 (41.2)		2948 (32.3)	
High school graduate	4354 (37.1)		177 (10.2)		3668 (40.2)	
Less than high school	1774 (15.1)		438 (25.2)		1338 (14.7)	
Family structure						
Two parents	7809 (64.9)		4 (0.0)			
One parent	3530 (29.3)		8162 (90.8)			

Other	701 (5.8)		826 (9.2)			
Family income, in thousands of dollars	40.0 (39.0)	0–999			10 (17.0)	0–260
Perceived neighborhood collective efficacy	6.0 (1.0)	1–6	6.0 (1.0)	1–6		
Perceived neighborhood contentment	4.0 (2.0)	1–5	4.0 (2.0)	1–5		
Perceived neighborhood safety						
Yes	10793 (89.8)		8159 (89.5)			
No	1225 (10.2)		956 (10.5)			
Depressive symptoms	5.0 (5.0)	0–25	5.0 (5.0)	0-27	3.0 (5.0)	0–23
Neighborhood structural disadvantage						
Concentrated poverty	-0.7 (2.3)	-2.8–13.4	-0.7 (2.2)	-2.7–13.6	-0.4 (0.1)	-0.9–19.5
Residential instability	0.1 (1.2)	-4.6–3.2	0.1 (1.2)	-4.6–3.3	0.1 (0.4)	-1.0–3.1
Immigrant concentration	0.4 (1.2)	-5.8–5.2	0.4 (1.2)	-6.0–5.3	-0.0 (0.2)	-5.6–0.6

Note. IQR=interqaurtile range

*Totals and percentages may not add up to the total sample size and 100, respectively, due to missing data and rounding

[ł]Due to rounding, values displayed may be zero

[§]Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations

[a]Wave I ocuppation and education was reported by the respondent for the parent and family income was reported by the parent

[b]Wave II occupation and education was reported by the respondent for the parent

[c]Wave III occupation, education, and family income was reported by and for the respondent

Table 2
Change in depressive symptoms and neighborhood structural disadvantage across Wave I, Wave II, and Wave III[ɨ]

	Intercept (SE)	Slope (SE)
Depressive symptoms	5.976 (0.045)***	-0.791 (0.028)***
Neighborhood structural disadvantage		
Concentrated poverty	-0.153 (0.019)***	0.033 (0.005)***
Residential instability	-0.093 (0.011)***	0.003 (0.003)
Immigrant concentration	0.263 (0.012)***	-0.030 (0.002)***

Note. SE=standard error
[ɨ]Due to rounding, values displayed may be zero
*p<0.05
**p≤0.01
***p≤0.001

Table 3
Random intercept growth curve models testing the effect of neighborhood structural disadvantage and neighborhood perceptions on depressive symptoms[ǂ]

	Intercept (SE)	Slope (SE)	
Time-invariant			
Gender			
Male	Ref.	Ref.	
Female	1.254 (0.079)***	-0.209 (0.048)***	
Race/ethnicity			
White, Non-Hispanic	Ref.	Ref.	
Hispanic	0.706 (0.121)***	-0.030 (0.080)	
Other, Non-Hispanic	0.792 (0.100)***	-0.085 (0.058)	
	Wave I[a] β (SE)	Wave II[b] β (SE)	Wave III[c] β (SE)
Time-variant			
Age	0.197 (0.020)***	0.149 (0.027)***	0.004 (0.022)
Occupation			
Professional/mangerial	Ref.	Ref.	Ref.
Other professional[§]	0.089 (0.104)	-0.185 (0.221)	0.010 (0.130)
Sales, service, administration	0.235 (0.110)*	-0.211 (0.219)	0.407 (0.127)**
Manual/blue collar	0.154 (0.124)	-0.232 (0.240)	0.164 (0.133)
Other (unspecified)	0.334 (0.111)**	-0.178 (0.239)	
Not working	0.128 (0.163)	-0.210 (0.235)	0.410 (0.119)**
Education			
College graduate	Ref.	Ref.	Ref.
Some college	0.039 (0.128)	1.038 (0.425)*	0.156 (0.103)
High school graduate	0.489 (0.095)***	0.751 (0.227)**	0.582 (0.112)***
Less than high school	0.889 (0.116)***	1.606 (0.228)***	1.002 (0.146)***
Family structure			
Two parents	Ref.	Ref.	
One parent	0.247 (0.093)**	1.579 (0.665)*	
Other	0.381 (0.105)***	1.855 (0.667)**	

Family income	-0.001 (0.001)		-0.002 (0.004)
Perceived neighborhood collective efficacy	-0.063 (0.037)	-0.118 (0.043)**	
Perceived neighborhood contentment	-0.643 (0.040)***	-0.593 (0.046)***	
Perceived neighborhood safety			
No	Ref.	Ref.	
Yes	-0.630 (0.145)***	-0.529 (0.170)**	
Neighborhood structural disadvantage			
Concentrated poverty	0.042 (0.023)	0.049 (0.026)	0.020 (0.012)
Residential instability	-0.045 (0.038)	0.035 (0.045)	0.294 (0.150)
Immigrant concentration	0.022 (0.035)	0.025 (0.039)	0.273 (0.230)

Note. SE=standard error

[t]Due to rounding, values displayed may be zero

[§]Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations

[a]Wave I ocuppation and education was reported by the respondent for the parent and family income was reported by the parent

[b]Wave II occupation and education was reported by the respondent for the parent

[c]Wave III occupation, education, and family income was reported by and for the respondent

*$p<0.05$

**$p\leq0.01$

***$p\leq0.001$

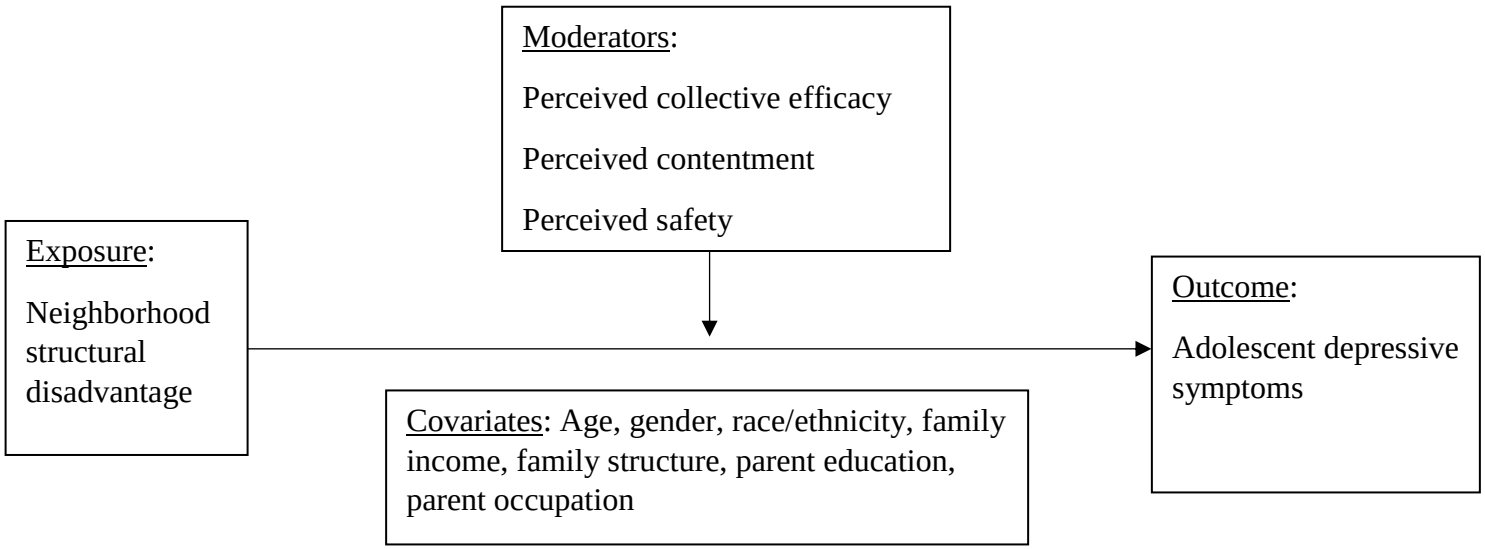

Figure 1. Adapted theoretical framework from Hill & Maimon (2013) linking neighborhood structural disadvantage and adolescent depressive symptoms

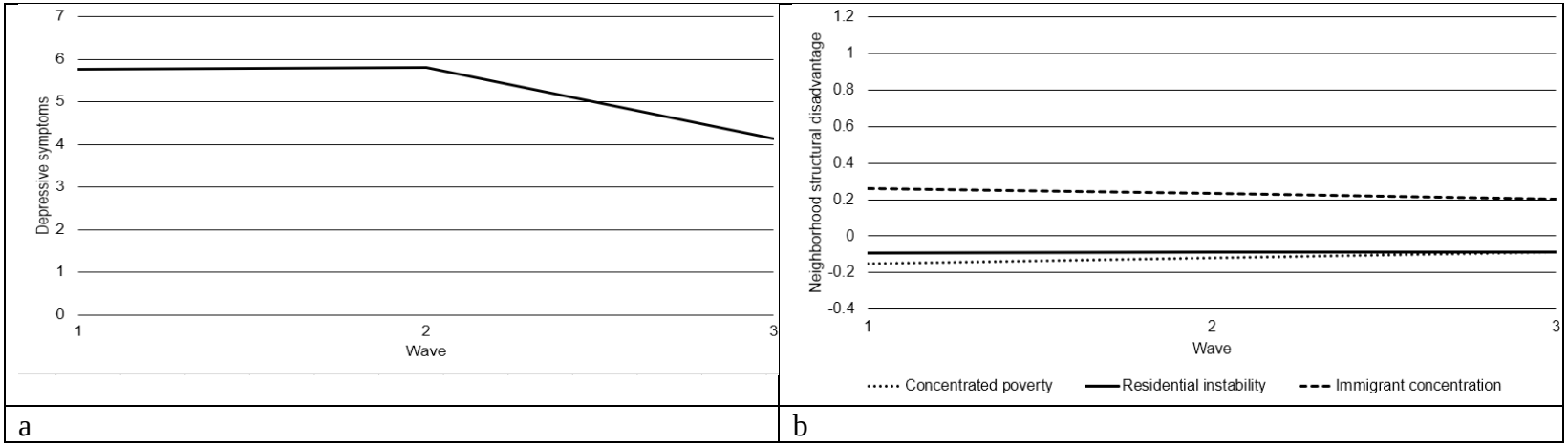

Figure 2. Mean levels of depressive symptoms (a) and neighborhood structural disadvantage (b) at Wave I, Wave II, and Wave III

Appendix A

Bivariate associations between depressive symptoms, neighborhood perceptions, and neighborhood structural disadvantage at Wave I, Wave II, and Wave III[ɨ]

	Wave I	Wave II	Wave III
	Spearman's coefficient (p-value) or Kruskal-Wallis x^2 (p-value)	Spearman's coefficient (p-value) or Kruskal-Wallis x^2 (p-value)	Spearman's coefficient (p-value) or Kruskal-Wallis x^2 (p-value)
Perceived neighborhood social cohesion	-0.09 (≤0.001)	-0.10 (≤0.001)	
Perceived neighborhood contentment	-0.22 (≤0.001)	-0.24 (≤0.001)	
Perceived neighborhood safety	243.43 (≤0.001)	204.18 (≤0.001)	
Neighborhood structural disadvantage			
Concentrated poverty	0.11 (≤0.001)	0.11 (≤0.001)	0.04 (≤0.001)
Immigrant concentration	-0.00 (0.76)	-0.00 (0.74)	0.01 (0.50)
Residential instability	0.01 (0.55)	-0.01 (0.37)	-0.04 (≤0.001)

Note.[ɨ] Due to rounding, values displayed may be zero

Appendix B

Random intercept growth curve models testing the interaction effects of neighborhood structural disadvantage and neighborhood perceptions on depressive symptoms[‡§]

	With interaction term perceived neighborhood collective efficacy			With interaction term perceived neighborhood contentment			With interaction term perceived neighborhood safety		
	Intercept (SE)	Slope (SE)		Intercept (SE)	Slope (SE)		Intercept (SE)	Slope (SE)	
Time-invariant									
Gender									
Male	Ref.	Ref.		Ref.	Ref.		Ref.	Ref.	
Female	1.257 (0.079)***	-0.212 (0.048)***		1.254 (0.079)***	-0.208 (0.048)***		1.253 (0.079)***	-0.208 (0.048)***	
Race/ethnicity									
White, Non-Hispanic	Ref.	Ref.		Ref.	Ref.		Ref.	Ref.	
Hispanic	0.692 (0.121)***	-0.022 (0.080)		0.697 (0.121)***	-0.026 (0.080)		0.705 (0.121)***	-0.029 (0.080)	
Other, Non-Hispanic	0.782 (0.100)***	-0.079 (0.058)		0.771 (0.100)***	-0.076 (0.058)		0.784 (0.100)***	-0.083 (0.058)	
	Wave I[a] β (SE)	Wave II[b] β (SE)	Wave III[c] β (SE)	Wave I[a] β (SE)	Wave II[b] β (SE)	Wave III[c] β (SE)	Wave I[a] β (SE)	Wave II[b] β (SE)	Wave III[c] β (SE)
Time-variant									
Age	0.195 (0.021)***	0.153 (0.028)***	0.002 (0.023)	0.198 (0.020)***	0.153 (0.027)***	0.004 (0.023)	0.196 (0.020)***	0.149 (0.026)***	0.005 (0.022)
Occupation									
Professional/mangerial	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Other professional[§]	0.091 (0.104)	-0.163 (0.227)	0.003 (0.130)	0.089 (0.104)	-0.180 (0.224)	0.013 (0.130)	0.086 (0.104)	-0.181 (0.218)	0.011 (0.130)

Sales, service, administration	0.230 (0.110)*	-0.182 (0.227)	0.405 (0.127)**	0.214 (0.110)	-0.198 (0.223)	0.412 (0.127)***	0.231 (0.110)	-0.210 (0.214)	0.408 (0.127)***
Manual/blue collar	0.162 (0.124)	-0.194 (0.250)	0.156 (0.133)	0.155 (0.124)	-0.214 (0.246)	0.171 (0.133)	0.155 (0.124)	-0.237 (0.231)	0.167 (0.133)
Other (unspecified)	0.331 (0.111)**	-0.151 (0.248)		0.327 (0.111)**	-0.154 (0.245)		0.336 (0.111)**	-0.179 (0.231)	
Not working	0.129 (0.164)	-0.182 (0.243)	0.404 (0.119)**	0.122 (0.164)	-0.184 (0.240)	0.415 (0.119)***	0.126 (0.163)	-0.211 (0.228)	0.414 (0.119)***
Education									
College graduate	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Some college	0.042 (0.128)	1.100 (0.417)**	0.148 (0.104)	0.044 (0.128)	1.211 (0.432)**	0.157 (0.103)	0.028 (0.127)	0.995 (0.393)*	0.159 (0.103)
High school graduate	0.487 (0.095)***	0.768 (0.228)***	0.577 (0.112)***	0.475 (0.095)***	0.729 (0.239)***	0.589 (0.112)***	0.486 (0.095)***	0.714 (0.225)***	0.585 (0.112)***
Less than high school	0.879 (0.116)***	1.618 (0.230)***	1.000 (0.146)***	0.872 (0.116)***	1.603 (0.237)***	1.013 (0.146)***	0.883 (0.116)***	1.569 (0.221)***	1.005 (0.146)***
Family structure									
Two parents	Ref.	Ref.		Ref.	Ref.		Ref.	Ref.	Ref.
One parent	0.242 (0.093)**	1.410 (0.800)		0.248 (0.093)**	1.528 (0.729)*		0.248 (0.093)**	1.694 (0.583)**	
Other	0.374 (0.106)***	1.681 (0.803)*		0.369 (0.105)***	1.793 (0.731)*		0.378 (0.105)***	1.973 (0.586)***	
Family income	-0.001 (0.001)*		-0.002 (0.004)	-0.001 (0.001)		-0.002 (0.004)	-0.001 (0.001)		-0.002 (0.004)
Perceived neighborhood collective efficacy	-0.046 (0.038)	-0.104 (0.045)*		-0.058 (0.037)	-0.116 (0.043)**		-0.064 (0.037)	-0.120 (0.042)**	

Perceived neighborhood contentment	-0.643 (0.040)***	-0.592 (0.046)***		-0.659 (0.041)***	-0.588 (0.048)***		-0.643 (0.040)***	-0.594 (0.046)***	
Perceived neighborhood safety									
No	Ref.	Ref.		Ref.	Ref.		Ref.	Ref.	
Yes	-0.664 (0.145)***	-0.547 (0.172)***		-0.715 (0.146)***	-0.630 (0.172)***		-0.717 (0.156)***	-0.626 (0.180)***	
Neighborhood structural disadvantage									
Concentrated poverty	0.425 (0.105)***	-0.207 (0.119)	0.020 (0.012)	0.318 (0.075)***	0.360 (0.087)***	0.020 (0.012)	0.098 (0.057)***	0.169 (0.065)***	0.020 (0.012)
Residential instability	-0.018 (0.182)	-0.073 (0.224)	0.300 (0.151)*	-0.102 (0.159)	0.004 (0.190)	0.293 (0.150)	-0.181 (0.121)	0.188 (0.163)	0.293 (0.150)
Immigrant concentration	0.145 (0.149)	0.229 (0.185)	0.275 (0.230)	-0.026 (0.132)	0.129 (0.140)	0.271 (0.229)	-0.009 (0.092)	0.059 (0.093)	0.274 (0.230)
<u>Interactions</u>									
Concentrated poverty x perceived neighborhood collective efficacy	-0.074 (0.020)***	0.031 (0.022)							
Residential instability x perceived neighborhood collective efficacy	-0.007 (0.035)	0.009 (0.043)							
Immigrant concentration x perceived neighborhood collective efficacy	-0.027 (0.029)	-0.041 (0.035)							
Concentrated poverty x perceived				-0.074 (0.018)***	-0.083 (0.021)***				

neighborhood contentment				
Residential instability x perceived neighborhood contentment	0.015 (0.038)	0.006 (0.046)		
Immigrant concentration x perceived neighborhood contentment	0.014 (0.032)	-0.026 (0.035)		
Concentrated poverty x perceived neighborhood safety			-0.069 (0.060)	-0.148 (0.071)*
Residential instability x perceived neighborhood safety			0.157 (0.127)	-0.179 (0.173)
Immigrant concentration x perceived neighborhood safety			0.043 (0.099)	-0.043 (0.103)

Note. SE=standard error

[ł]Due to rounding, values displayed may be zero

[§]Other professional – community/social services, education/training/library, and arts/design/entertainment/sports/media occupations

[a]Wave I ocuppation and education was reported by the respondent for the parent and family income was reported by the parent

[b]Wave II occupation and education was reported by the respondent for the parent

[c]Wave III occupation, education, and family income was reported by and for the respondent

*p<0.05

**p≤0.01

***p≤0.001

CONCLUSIONS

To our knowledge, this is the first study examining the effect of structural disadvantage on depressive symptoms as well as the moderating role of neighborhood perceptions of the social environment (i.e. collective efficacy, safety, contentment, disorder) on the relationship between structural disadvantage and depressive symptoms among adolescents, a population experiencing an increase in the prevalence of depression over the last decade. The findings of these studies extend our knowledge of how neighborhood structural disadvantage and social environment of communities influence mental health among adolescents. We found that perceptions of the neighborhood social environment were associated with adolescent depressive symptoms. After controlling for individual and neighborhood level characteristics, parental-perceived neighborhood disorder was significantly associated with higher levels of adolescent depressive symptoms (β=0.27, SE=0.05, $p \leq 0.001$). Adolescent-perceived neighborhood social cohesion (β=0.24, SE=0.04, $p \leq 0.001$) and safety (β=0.47, SE=0.04, $p \leq 0.001$) were significantly associated with lower depressive symptoms among adolescents after controlling for individual and neighborhood level characteristics. However, parental-perceived collective efficacy was not associated with adolescent depressive symptoms ($p > 0.05$). The interactions between neighborhood concentrated poverty and parental-perceived neighborhood disorder; adolescent-perceived neighborhood collective efficacy, contentment, and safety were also significant ($p \leq 0.05$). Parental-perceived neighborhood disorder, adolescent-perceived neighborhood collective efficacy, contentment, and safety moderated the association between structural disadvantage and adolescent depressive symptoms. In the cross-sectional analysis, at low and high levels of parental-perceived

neighborhood disorder, concentrated poverty was associated with lower (β=-0.41, $p<0.05$) and higher (β=0.46, $p\leq0.01$) levels of depressive symptoms, respectively. At intermediate (β=-0.13, SE=0.06, $p<0.05$) and higher levels (β=-0.22, SE=0.07, $p\leq0.01$) adolescent-perceived neighborhood social cohesion, neighborhood structural disadvantage was associated with a decrease in depressive symptoms. In the longitudinal analysis, at higher levels of adolescent-perceived neighborhood collective efficacy and contentment, concentrated poverty was associated with lower depressive symptoms (collective efficacy: β=-0.46, SE=0.04; contentment: β=-0.59–-0.66, SE=0.04–05). For adolescents who perceived their neighborhood as being safe, concentrated poverty was associated with lower depressive symptoms (β=0.626, SE=0.180, $p<0.05$). Parental-perceived collective efficacy was not found to be a moderator ($p>0.05$). In addition, our findings support our adaptation of Hill and Maimon's (2013) theoretical framework. The results of our study partially support the predicted interactions between neighborhood structural disadvantage and neighborhood perceptions of the social environment. Neighborhood disorder, collective efficacy, contentment, and safety were found to moderate the association between neighborhood structural disadvantage and adolescent depressive symptoms and the association between concentrated poverty and adolescent depressive symptoms. Collective efficacy, contentment, and safety decreased the strength of the association between neighborhood structural disadvantage and depressive symptoms while neighborhood disorder increased the strength of the association between neighborhood structural disadvantage and depressive symptoms. No moderation by neighborhood perceptions was found for the associations between neighborhood residential instability and immigrant concentration and adolescent depressive symptoms.

The study's findings advance the understanding of the relationship between neighborhood processes and adolescent depression. Findings could help in the identification of neighborhood characteristics that impact depression among adolescents in the U.S. to inform the design of multilevel and other interventions. Such interventions may be neighborhood-based involving residents in entire communities to address perceptions of the neighborhood social environment that could influence adolescent depression. Perceived neighborhood collective efficacy may be targeted in an intervention and thus increased by providing residents opportunities to engage in community activities that build social ties, solidarity, and trust (Chung et al., 2009). Perceived neighborhood contentment may be targeted in a community intervention by addressing factors that have been found to influence resident satisfaction such as safety from crime, cleanliness, access to recreational activities, and general appearance (Hur & Morrow-Jones, 2008). In addition, perceived neighborhood safety may be targeted by addressing resident concerns about crime, which may involve increasing neighborhood enforcement of laws and safe-ride programs (Assari & Caldwell, 2017; Kondo, Andreyeva, South, MacDonald, & Branas, 2018). The neighborhood social environment may be more a more feasible target to address in a multilevel intervention involving different levels of social organization (i.e. individual residents, neighborhood-based groups, entire communities) than the neighborhood structural environment.

Furthermore, the influence of neighborhood social environment varied by the neighborhood perception examined, suggesting a need to modify multilevel and other interventions based on varying levels of structural disadvantage. Even so, interventions aimed at increasing collective efficacy for mental illness prevention have been found to

be promising (Chung et al., 2009). A survey conducted among Los Angeles, California residents found that exposure to community engagement activities led to an increase in perceived neighborhood collective efficacy to address depression (Chung et al., 2009). In addition, a randomized-controlled trial aimed at changing the neighborhood structural environment of participants by moving families from public housing in neighborhoods with high levels of concentrated poverty to private housing in low concentrated poverty neighborhood was found to decrease depressive symptoms (Kling, Liebman, & Katz, 2007; Leventhal & Brooks-Gunn, 2003). Interventions with collective efficacy as a target have been successful in primary prevention strategies for other health outcomes such as HIV/AIDS and sexually transmitted diseases by improving HIV/AIDS competence through increased knowledge and understanding about AIDS transmission, which led to an increase in collective efficacy to address HIV/AIDS, and lowering risky sexual behaviors (Bell et al., 2008; Carlson, Brennan, & Earls, 2012).

Concentrated poverty, a component of structural disadvantage, and neighborhood perceptions of collective efficacy, contentment, disorder, and safety could serve as targets for the development of intervention strategies aimed at reducing depression. Increasing neighborhood collective efficacy, contentment, and safety, and reducing neighborhood disorder in order to improve the mental health of residents, including adolescents, has been suggested in the literature (Ahern & Galea, 2011; Assari & Caldwell, 2017; Ford & Rechel, 2012; Fullerton et al., 2015; Grogan-Kaylor et al., 2006). Ultimately, addressing neighborhood structural disadvantage and improving collective efficacy along with neighborhood contentment, neighborhood safety, and neighborhood disorder may help to

reduce and prevent depressive symptoms among adolescents, thereby reducing the growing mental health burden among youth.

VITA

CHRISTYL TERES DAWSON

2008–2013	B.S., Biology and mathematics
	University of Miami
	Coral Gables, Florida
2013–2015	M.P.H., Epidemiology
	Florida International University
	Miami, Florida
2015–2017	C-SALUD Student Scholar in Health Disparities Research Fellow
	Florida International University
	Miami, Florida
2018–present	Pre-doctoral Ruth L. Kirschtein Research Service Award Fellow
	Florida International University
	Miami, Florida
2017–present	Doctoral Candidate
	Florida International University
	Miami, Florida

PUBLICATIONS AND PRESENTATIONS (Selected)

Cyrus E., Dawson C., Fennie K. P., Sheehan D. M., Mauck D. E., Sanchez M., . . . Trepka M. J. (2017). Disparity in retention in care and viral suppression for HIV-infected Black Caribbean-born immigrants in Florida. *International Journal of Environmental Research and Public Health, 14*(3), pii: E285.

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Dawson, C. T., Wu, W. Pettit, J. W., & Trepka, M. J. (2019, March). *Collective efficacy moderates association between concentrated poverty and adolescent depression*. Poster presented at the 65th Southeastern Psychological Association Annual Meeting, Jacksonville, FL.

Dawson, C. T., Wu, W., Pettit, J. W., & Trepka, M. J. (2019, March). *The Relationship between Perceived Neighborhood Collective Efficacy and Mental Health Service Utilization among Adolescents*. Poster presented at the 32nd Annual Research and Policy Conference on Child, Adolescent, and Young Adult Behavioral Health, Tampa, FL.

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