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The Latent Threat of Community Violence: Indirect Exposure to Local Homicides and Adolescents' Mental Health in Colombia

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Abstract

This study examines the relation between adolescents' indirect exposure to local homicides and mental health disorders and PTSD symptoms. We employ a sample of 300 adolescents ($M_{age} = 14.52$, $range = 12-17$) representative for Bogotá, Colombia, and geocoded data on violent crimes recorded by the national police. Findings show that one SD increment in local homicides is associated with increments by 0.17 SD in the mental health disorder index and a 0.14 SD increase in the PTSD score index, even after accounting for adolescents' direct exposure to violence. The estimated effect for PTSD was larger for adolescents' who were directly exposed to violence and for those living in multidimensionally poor households, whereas no detectable effects were found for adolescents who perceived their residential neighborhood as safer.

Keywords

Community Violence; Mental Health; Post-traumatic Stress Disorder; Adolescence; Colombia

Community violence has long been recognized as a global public health problem (WHO, 2002). Every year more than a million people worldwide lose their lives to self-inflicted, interpersonal, or collective violence (UNODC, 2014). Moreover, an estimated 200,000 homicides occur each year among 10- to 29-year-olds making homicide the fourth leading cause of death among adolescents and young adults globally (WHO, 2016). And while these numbers are shocking, they grossly underestimate the impact that community violence has on global health. Community violence not only affects those who are directly victimized, but also those who are indirectly touched by community violence either by knowing a victim, hearing about a violent act, or simply living in a violent area (Sharkey, 2018). In fact, a growing body of research has linked exposure to community violence (broadly defined) to detriments in psychological functioning among adolescents across a variety of outcomes including posttraumatic stress disorder (PTSD), externalizing disorders (e.g., delinquency, aggressive behavior), and internalizing disorders (e.g., depression and anxiety; Fowler, Tompsett, Braciszewski, Jacques-Tiura, & Baltes, 2009; McDonald & Richmond, 2008).

Estimates reveal that one in four people worldwide are likely to suffer from mental health disorders at some point in their lives, placing this burden as one of the leading causes of disability in the world (Vigo, Thornicroft, & Atun, 2016; WHO, 2016). Some evidence show that half of mental disorders begin by the age of 14 (Kessler et al., 2005), suggesting that adolescence is a critical period to intervene. Although prevalence data for mental health in adolescents is limited, especially in low-and-middle income countries (LMICs), globally it is estimated that between 6.7 and 19.8 percent of adolescents suffer from mental health disorders (Erskine et al., 2017). Longitudinal studies show that mental health disorders during adolescence are linked to an array of educational and behavioral problems, as well as to lower income, labor supply, and marriage stability years later during adulthood (Goodman, Joyce, & Smith, 2011). As such, mental health disorders constitute one root of social disparities, undermining millions of individual's prospects and well-being.

Despite clear evidence that both community violence and mental health disorders are global health concerns, questions remain as to how they are related. Specifically, little is known about the way indirect exposure to community violence (i.e., local-area violence) is related to adolescents' mental health, even after accounting for direct exposure to violence; does living in a dangerous place negatively impact adolescents' mental health regardless of direct victimization or witnessing a violent crime? Moreover, the factors that might exacerbate or protect against these negative effects are not well understood. This study aims to fill these gaps by using a novel dataset that allow us to examine how adolescents' indirect exposure to local area homicides, controlling for adolescents' direct exposure to community violence, is related to symptoms of mental health problems and PTSD. We follow Sharkey (2018) to define direct exposure to community violence as being directly victimized or witnessing an incident (which is the typical conceptualization of exposure to violence in related studies), whereas exposure to violent residential environments (i.e., local area crime) is said to be indirect exposure to community violence. We also consider how selected contextual risk (i.e. household poverty, direct victimization) and protective factors (i.e. social support, perception of neighborhood security) moderate the association between indirect exposure to local homicides and mental health. In doing so, we offer novel evidence of the relation between community-level violence exposure and adolescents' mental health, influences which may have long-term implications for adolescents' functioning and developmental trajectories.

Exposure to Community Violence and Adolescent's Mental Health

There is a growing body of research linking community violence exposure to detriments in adolescents' psychological outcomes. Two meta-analyses (Fowler et al., 2009; McDonald & Richmond, 2008) have examined the relation between community violence exposure and adolescent mental health and found consistent evidence of higher rates of PTSD symptoms, externalizing symptoms (e.g., delinquency, aggressive behavior), and internalizing disorders (e.g., depression and anxiety) among youth reporting higher rates of community violence exposure. Moreover, one meta-analysis found the strength of these relations to vary by *type* of exposure (Fowler et al., 2009). Reports of direct victimization most strongly predicted symptoms of PTSD, externalizing symptoms (e.g., delinquency, aggressive behavior), and internalizing disorders (e.g., depression and anxiety) while reports of witnessing violence were strongly related to externalizing symptoms, while both witnessing and "hearing about"

violence predicted internalizing symptoms. However, the vast majority of studies included in these reviews relied on self-report measures of community violence exposure rather than community-level measures of violent crime rates.

Few studies have examined the relation between local-area violence reports in close-proximity to adolescents' homes and adolescent functioning. This is important for both methodological and conceptual reasons. First, self-report measures of exposure to community violence may be confounded with psychological symptoms; adolescents who are experiencing the negative psychological effects of violence exposure may be more (or less) likely to report violence exposure (McCoy, 2013). Second, self-report violence exposure measures ignore the possibility that community-level violence may affect individual mental health even after accounting for direct exposure to violence. The level of violent crime in a community can shape the way that residents interact with community space and each other, factors which have the potential to shape adolescent mental health and development.

Some studies that have examined relations between reports of local-area violent crime and adolescents' self-regulation, skills hypothesized to underlie cognition and behavioral adjustment, provide notable exceptions (e.g., McCoy, Roy, & Raver, 2016; Sharkey, Tirado-Strayer, Papachristos, & Raver, 2012). For example, McCoy et al. (2016) found that living in a high-crime neighborhood in Chicago predicted 5th and 6th graders' greater selective attention towards negatively valenced emotional stimuli on a dot probe task and less biased appraisal of fear on a facial identification task. More recently, Grinshteyn, Xu, Manteuffel, and Ettner (2018) found an association between crime rates at the zip code level and behavioral health outcomes for 11- to- 18-year-olds in United States, even after controlling for adolescents' self-reported crime exposure.

Similar studies have analyzed the effect of local-area measures of community violence on local inhabitants' mental health (not specifically on adolescents). A longitudinal study by Cornaglia, Feldman, and Leigh (2014) showed that increments in community violence at the Local Government Area (LGA) of metropolitan Australia had a negative effect on mental health of local inhabitants. Similarly, Dustmann and Fasani (2016) found that local-area measures of crime at the level of the Local Authority (LA) in England and Wales was related to symptoms of depression and anxiety for residents with an effect size that was larger than what was estimated for a comparable decrease in local employment. Although these studies have made important contributions to understanding how community violence affects mental health of local inhabitants in high income countries, less is known about how local-area crime may relate to adolescents' mental health specifically, particularly in LMICs where urban violent crime, especially homicides, are more prevalent (UNODC, 2014). Furthermore, most studies have used aggregate measures of exposure at relatively large nationally-established areas (e.g., at the zip code area, LGA or LA), which may misrepresent real exposure levels for households living at the extremes of the crime distribution.

The Moderating Role of Contextual Risk and Protective Factors

After determining *if* indirect exposure to local area homicides matters for adolescent mental health, the challenge becomes identifying contextual factors that might exacerbate or protect

against these effects. This information will be critical for both researchers and practitioners looking to identify strategies for violence prevention and health promotion. In this paper we explore the moderating role of four factors identified in prior work as being important predictors of adolescent mental health and conceptually relevant to community violence exposure. Although these four factors are in no way exhaustive of all potential moderating influences, we chose to focus on these because they represent stressors and supports across multiple contextual levels (i.e. individual, family, and neighborhood) that prior work suggests may shape how youth experience and respond to community violence.

Household poverty.

There is a long-standing and robust body of literature demonstrating a negative relation between growing up in poverty and child and youth mental health (Yoshikawa, Aber, & Beardslee, 2012). A systematic review of studies on socioeconomic inequality and mental health problems in children and youth revealed consistent evidence of an inverse relation between socioeconomic status and mental health; socioeconomically disadvantaged children and youth were two to three times more likely to develop mental health problems than their more advantaged peers (Reiss, 2013). Moreover, having low socioeconomic status that persisted over time put youth at even greater risk for developing mental health problems (Reiss, 2013). Consequently, the stress associated with living in a high-crime area might be further compounded by living in poverty, which could in turn increase adolescents' risk of developing a mental health problem.

Direct victimization and witnessing violence.

As described above, direct victimization is one aspect of community violence exposure. In fact, prior work has found direct victimization to be a more robust predictor of mental health problems than hearing about community violence (Fowler et al., 2009). However, while few studies have tested models which include both indirect (i.e., local-area) and direct exposure measures of community violence, even less have considered how the interaction between both types of exposure may shape the influence that victimization has on mental health. It could be that the experiences of living in a high-crime area and direct victimization each have stress and trauma associated with them which is compounded when they both occur, putting youth at greater risk for developing a mental health problem. Alternatively, the levels of local violence may be more salient for adolescents who have been victimized, exerting a stronger negative influence on their mental health in comparison to adolescents living in the same area that have not been directly exposed (i.e., victimized or have not witnessed a crime).

Social support.

Just as household poverty and direct victimization may exacerbate the risks of indirect exposure to community violence on mental health, the presence of social support in youths' lives may also protect against it. Some studies provide support for this hypothesis (e.g., O'Donnell, Schwab–Stone, & Muyeed, 2002; Ozer & Weinstein, 2004; Rosario, Salzinger, Feldman, & Ng-Mak, 2008). However, others have failed to find evidence of social support serving as a protective factor against the manifestation of mental health problems associated with exposure to community violence (Davis, Ammons, Dahl, & Kliwer, 2015; Paxton,

Robinson, Shah, & Schoeny, 2004). But no one, to our knowledge, has examined the protective role of social support in the relation between indirect exposure to local-area homicides, accounting for direct exposures, and youth mental health.

Perception of neighborhood security.

The sense of security that residents feel in their neighborhood space may also serve to protect against the potential negative influences of crime on mental health. Although all individuals living within geographic proximity of each other may be exposed to comparable levels of neighborhood crime, there may be individual differences in the ways that residents perceive crime as threatening or strategies employed for navigating a high-crime area that may make its influence more or less salient. Some prior research has shown perceived neighborhood safety to be related to indicators of adolescents' mental health and well-being such as lower rates of anxiety (Cooper-Vince, Chan, Pincus, & Comer, 2014) and depression (Ford & Rechel, 2012). Therefore, it may be that perceptions of neighborhood safety and security protect youth against the emergence of mental health problems regardless of the observed levels of neighborhood crime in an area.

The Present Study

The present study seeks to answer these questions using a unique dataset that combines survey information on a representative sample of adolescents (12 to 17 years old) living in Bogotá, Colombia with spatially-linked crime statistics. This work will make several important contributions to the existing literature on community violence exposure and adolescent mental health. First, our dataset, which combines spatially-linked prior year homicide rates with rich information on adolescent mental health and context, allows us to estimate relations between adolescents' indirect exposure to local area homicide, in a small geographic area, and mental health outcomes (i.e. a global measure of mental health disorder and PTSD symptoms) after adjusting for adolescents' direct exposure to community violence exposure. This will provide critical information on whether setting-level homicide rates play a role in adolescent mental health even after accounting for adolescents' direct exposure (i.e., victimization or witnessing a crime).

Moreover, we test the moderating role of four key risk and protective factors shown in prior work to play a role in adolescent mental health. Understanding the factors that may exacerbate or protect against community violence exposure will be critical for the development of effective prevention strategies. Finally, we position these questions in the context of Bogotá, Colombia, a city that one time was considered to be one of the most violent cities in the world (Levitt & Rubio, 2000). Although crime rates in Colombia have dropped dramatically in the past twenty years, understanding the influence that violent crime has on youth development is particularly important given this historical context, and given that recent trends show increases in urban criminality (Mejia, Ortega, & Ortiz, 2015).

Method

Participants

Data from three sources are used in this study. First, individual and household data were taken from the 2015 Mental Health Survey of Colombia (ENSM for its acronym in Spanish; Ministerio de Salud & Colciencias, 2015). The ENSM is a cross-sectional survey, representative of 12- to 17-year-olds at the national level and for Bogotá, Colombia's capital city. Participants were selected through a multi-staged, stratified random sampling, using residential blocks as primary sampling units (for more details see Ministerio de Salud & Colciencias, 2015). Broadly, the ENSM provides information about household characteristics (reported by the household head) and adolescents' mental well-being and experiences (reported by the adolescent). Under a special permission granted by the Colombian Ministry of Health for the purpose of this study, it was possible to obtain the city block where ENSM's surveyed households were located, which were geocoded using ArcGIS 10.5.1 software. Bogotá's ENSM surveys were conducted between January 24th and May 16th of 2015.

Second, the Statistical, Contraventional, and Operational Information System (SIEDCO for its acronym in Spanish), gathered by the National Police Department, was geocoded and spatially combined with ENSM data. SIEDCO reports the date, hour, and latitude and longitude (i.e., precise spatial location) where different crimes took place, including homicides, personal injuries, theft to people, drug-related crimes, and reports and operations related to domestic violence. SIEDCO data is available from January 1th, 2014 to December 31th, 2015. In this paper, we focus on homicides, as it is a particularly salient crime and the one least prone to be underreported (i.e., with the lowest measurement error; Ministerio de Defensa de Colombia, 2018). Lastly, information about the spatial location of neighborhood resources and infrastructure was obtained from a dataset compiled by CESED at Universidad de los Andes.

Table 1 summarizes descriptive statistics for the 300 adolescents that were included in Bogotá's ENSM and that make up our analytical sample. On average, sampled adolescents were 14.42 years old, 52 percent were female, five percent belonged to an ethnic minority, and 88 percent attended school in 2015. Seventy-one percent of adolescents' mothers had completed at least secondary education. Lastly, sampled adolescents were nested in 120 city blocks; on average, there were 6.29 adolescents per block ($SD = 6.77$, $range = 1-25$).

Measures

Mental health disorders.—Symptoms of mental disorders were assessed through the Self-Reporting Questionnaire (SRQ). The SRQ was developed by the World Health Organization (WHO) to assess the prevalence of common mental disorders in low income settings (WHO, 1994). This instrument has been validated and used both in international contexts (e.g., WHO, 1994) and in Colombia (Harpham, Grant, & Rodriguez, 2004). A summary symptom score was computed, ranging from zero (the adolescent did not present any symptom) to 20 (the adolescent presented all symptoms). Cronbach's alpha (α) for this

scale if 0.83, showing a good internal consistency. As shown in Table 1, on average adolescents in Bogotá suffered from 2.06 out of 20 assessed symptoms in the previous year.

Post-Traumatic Stress Disorder (PTSD).—Symptoms of PTSD were assessed using the Post-Traumatic Stress Disorder Checklist (PCL). The PCL is a 20-item self-reported questionnaire that identifies the 20 Diagnostic and Statistical Manual of Mental Disorders (DSM-5) symptoms of PTSD (Blanchard et al., 1996; Ruggiero, et al., 2003). A total symptom severity score was obtained summing the scores for each of the 20 items ($\alpha = 0.92$). On average, adolescents in Bogotá suffered 0.76 out of 20 PTSD assessed symptoms.

Indirect exposure to local homicides and other crimes.—Once sampled households' and crimes were spatially combined, the number of homicides and other crimes that occurred within 150 meters around each block in the preceding 12 months (i.e., 364 days) before each household's ENSM survey, were counted. On average, sampled adolescents were indirectly exposed to 0.97 homicides, 6.57 personal injuries, 7.95 cases of theft to people, 4.04 cases of domestic violence, and 7.99 drug-related crimes within 150 meters around the blocks where they lived in the year before their ENSM survey (see Table 2 for details). The same approach was used to count the number of crimes happening within different radial distances, from 50 meters (approximately 5 blocks) to 300 meters (approximately 50 blocks) with 50 meters increments, as well as the number of crimes that happened in closer proximity, within the block where the household was located (see Table A1 for descriptive statistics).

Potential moderators.—To assess the role of selected risk and protective factors as potential moderators, we draw a set of characteristics from the ENSM survey. First, a binary indicator for whether adolescents were a direct victim or witnessed an incident of violent crime (i.e., direct exposure; 21 percent) was used (the ENSM directly asked adolescents if they have been a direct victim or witnessed an incident in their lives). Second, we computed a continuous summary score index for availability of support, including whether adolescents can lean on someone to discuss their problems and the frequency with which adolescents can lean on someone in economic hardship ($\alpha = 0.75$, $M = 4.34$). Third, adolescents stated their perceptions about neighborhood security in a continuous scale from 0 (most insecure neighborhoods) to 100 ($M = 44.44$). Finally, the ENSM included several questions about household characteristics and each one of its members, allowing computing a Multidimensional Poverty Index –MPI using the Alkire-Foster method (Alkire & Foster, 2011). Overall, the index counts the number of weighted deprivations that a household experienced in health, education, access to public services and housing conditions, labor conditions, and childhood and youth conditions. Following the Colombian MPI (DANE, 2016), a household was said to be poor if it experienced at least four out of 12 possible deprivations. Thirteen percent of sampled adolescents were living in households considered as poor according to the MPI.

Individual, household, and neighborhood covariates.—Individual and household characteristics were taken from the ENSM survey, including adolescents' age, sex, ethnicity, whether they were attending school, and mother's education level. Surveyed adolescents

also stated whether they suffered from any of the following Adverse Childhood Experiences (ACE): i) adults around did not express affect or neglected them, ii) one of their parents or main caregivers died; iii) they have a serious sickness. Adolescents also stated whether in the past year they had been seriously sick or exposed to another stressor. Questions about participation in different social groups were also included. Finally, neighborhood characteristics were taken from the CESED dataset. The presence of police stations, parks, hospitals, schools, and sport centers were spatially combined with the location of households to characterize the access to neighborhood resources. See Table 1 for details. Table A2 presents correlations for all the variables included in the study.

Data analysis

To analyze the association between local-area homicides and mental health outcomes, we estimated the multivariate regression model presented in Equation 1 by Ordinary Least Squares (OLS). In Equation 1, Y_{ib} represented the standardized outcome variable (i.e., SRQ summary symptom score or PCL symptom severity score) for adolescent i living in the city block b , and $Homicides_{ib}$ was a standardized measure of the number of local-area homicides that occurred 150 meters around block b in the preceding year before the ENSM survey. In this model, β represented the association between local-area homicides and the outcome variable and, if statistically significant, demonstrates the average change in standard deviations in the outcome variable given an increment in one standard deviation in the number of local homicides.

$$Y_{ib} = \alpha + \beta Homicides_{ib} + Crimes_{ib}\gamma + Covar_{ib}\theta + \varepsilon_{ib} \quad (1)$$

Control variables were added gradually in subsequent estimations to assess the robustness of estimates. In the model, $Crimes_{ib}$ was a vector including the number of personal injuries, theft of people, cases of domestic violence, and drug-related crimes occurring in the same spatial area and temporal window abovementioned, whereas $Covar_{ib}$ was a vector of individual, household, and neighborhood covariates for adolescent i living in the block b , including a binary variable that indicates whether the adolescent was a victim of or witnessed a crime in the year before the ENSM survey. As such, γ represented a vector of coefficients for the association between different crimes and the outcomes and θ was a vector of coefficients for the relation between covariates and the outcome variables. Lastly, ε_{ib} represented residual error and captured omitted variables in the model. As a sensitivity analysis to check for potential specification-driven results, we also estimated additional regression models using as predictors the number of local-area homicides and other crimes occurring within the block (which is an officially established city unit), as well as within 50, 100, 200, 250, and 300 meters around the block.

Furthermore, to assess whether the association between local-area homicides and the outcome variables differed between sub-populations, we performed a set of moderation analyses. In Equation 2, δ represented the association between the moderator ($Moder_{ib}$) and the outcome variable, and the coefficient for the interaction, ϕ , when statistically different from zero, represented the difference in the magnitude of the association between homicides and the outcome variable for the sub-population of interest. We tested whether there were

heterogeneous associations given the following risk factors: (1) living in a multidimensional poor household (12.7% of the sample) versus not living in poverty; and (2) having been directly victimized or witnessing a crime (21.33%) versus not being victimized or witnessing. Besides, we tested the following protective factors: (1) scoring at least above the first standard deviation in the social support index (i.e., having some sources of support; 74.7% of the sample) against scoring below the first standard deviation; and (2) perceiving the neighborhood as safe (i.e., scoring above the mean in the self-reported neighborhood security; 49.7%) against perceiving it as insecure.

$$Y_{ib} = \alpha + \beta Homicides_{ib} + \delta Moder_{ib} + \varphi Homicides_{ib} * Moder_{ib} + Crimes_{ib}\gamma + Covar_{ib}\theta + \epsilon_{ib} \quad (2)$$

We standardized (i.e., transformed to a variable with mean zero and standard deviation one) continuous variables throughout analyses, especially indexes, to better interpret and compare the estimated coefficients. Moreover, all regression models were assessed using clustered-robust standard errors to account for the nesting of households within residential neighborhoods. All analyses were conducted using Stata 15.1 software.

Results

We summarize our main results in Table 2. The first three columns present different model specifications for the association between the standardized number of local-area homicides (within a 150 meters radial distance the 12 months preceding the survey) and the standardized measure of SRQ mental health symptoms, controlling for exposure to other crimes (Column 1), individual and household covariates, including victimization and witnessing any crime (Column 2), and risk and protective factors as well as neighborhood characteristics (Column 3). The subsequent three columns (4, 5, and 6) follow the same structure for the relation between homicides and PCL severity symptom score (Table B1, in the appendix, presents results for all covariates).

Results from the most conservative model (i.e., including all covariates) suggest that local-area homicides, holding witnessing or being directly victimized by a crime constant, predicted higher levels of overall psychological distress. Findings show that 1 SD increase in the number of local homicides (i.e., within 150 meters) in the year preceding the ENSM survey was associated with increases of 0.17 SD ($SE = 0.06$; $p < 0.01$) in the summary score for the SRQ mental health index and 0.14 SD ($SE = 0.06$; $p < 0.05$) in the PTSD severity score index, even after controlling for a set of individual, household, and neighborhood covariates. The results are robust to different model specifications; particularly to the inclusion of different sets of control variables (see Table 2 for details).

Furthermore, sensitivity analyses reveal that the findings are robust to different specifications of indirect exposure to local-area homicides (i.e., spatial areas). First, the estimated coefficient for the association between the standardized measures of homicides and SRQ score lies between 0.13 and 0.17 SD when considering exposures in the block or 50 to 200 meters surrounding the residence (with 50 meters increments), but the statistical association dissipates for areas larger than 200 meters, which is a spatial area that contains

on average more than 30 blocks around (see Figure C1 for details). Second, the estimated effect for PTSD is statistically significant for exposures within 100, 150, and 200 meters, with an estimated coefficient that lies between 0.11 and 0.14 SD, but not for larger spatial areas nor for the block and 50 meters specifications (see Figure C2 for details).

Testing the moderating role of risk and protective factors

Table 3 summarizes results of moderation analyses of the association between local-area homicides and the mental disorders summary score, controlling for other individual, household, and neighborhood covariates (see Equation 2). The table presents results for the overall association between homicides and the score, as well as the coefficient for the moderator (δ in Equation 2) and the coefficient for the interaction between homicides and the moderator (ϕ). The findings indicate that perception of neighborhood security is a marginally significant moderator; the estimated coefficient for the relation between homicide and mental disorders was -0.24 SD ($SE = 0.13$; $p < 0.10$) for adolescents who perceive their neighborhoods as safer but 0.23 SD ($SE = 0.07$; $p < 0.01$) for those that consider the neighborhood as insecure. No evidence of moderation was found for risk factors nor for the social support index.

Table 4 presents moderation analyses of the association between local-area homicides and the PTSD severity score index. Our findings indicate that the association between local-area homicides and PTSD symptoms differed depending on adolescents' exposure to several risk and protective factors. First, the estimated coefficient for the interaction was 0.55 SD ($SE = 0.13$; $p < 0.01$) for adolescents living in households considered as poor using the multidimensional poverty index, whereas no statistical effect was detectable for adolescents living in households not considered as poor. Second, the estimated ϕ was 0.45 SD ($SE = 0.12$; $p < 0.01$) for adolescents who were directly victims of a crime, against a coefficient that was not statistically different from zero for adolescents not directly victimized ($\beta = 0.02$; $SE = 0.06$). Third, the estimated ϕ equaled -0.19 SD ($SE = 0.10$; $p < 0.10$) for adolescents perceiving their neighborhoods as safer, against 0.20 SD ($SE = 0.07$; $p < 0.01$) for those perceiving their neighborhoods as insecure. No statistically significant moderation was found for the social support index.

Discussion

A large body of evidence has shown links between community violence (including direct and indirect exposure) and local inhabitants' mental health (e.g., Dustmann & Fasani, 2016; Fowler et al., 2009). Building on this literature, this study considers the relation between local-area homicides near adolescents' households and adolescents' mental health, even after accounting for their direct exposure to community violence in Bogotá, Colombia, a city whose homicide rate per 100,000 inhabitants (16.6 in 2015) is superior to those found in nearby Latin American capitals such as Lima (5.0) and Quito (5.7), considerably lower than those found in Caracas (119), and similar to those found in US cities such as Chicago (Blattman et al., 2017; Mejía et al., 2015). In doing so, this study aims to disentangle the effect of living in a homicide-ridden community from that of being directly exposed to

violence, a limitation highlighted in past work (e.g., McCoy et al., 2016), and offer evidence for the critical role that contextual violence plays in youth development (Sharkey, 2018).

Results from this study show that after adjusting for direct victimization, local area homicides are related to increases in adolescents' mental disorder symptomatology. Specifically, we found that a difference of 1 SD in the number of homicides occurring within 150 meters around adolescents' residential blocks in the 12 months preceding the assessment was linked to 0.17 SD increase in the summary score for the SRQ mental health index and 0.14 SD increase in the PTSD severity score index. Moreover, these estimates are robust to different model specifications, to the inclusion to several individual, household, and community-level covariates, and to different radial distances around each city block where ENSM surveyed adolescents lived to operationalize the exposure to crimes.

Why might living in a violent community influence adolescent mental health and development even after accounting for direct victimization? Decades of research from the fields of sociology and criminology have described links between the structural conditions of neighborhood space, community crime, and neighborhood norms and resident influence (e.g. Sampson, Raudenbush, & Earls, 1997). This work has argued that neighborhoods characterized by high rates of crime have experienced a breakdown in collective efficacy, or normative expectations for prosocial action in combination with neighborhood-level trust. As such, neighborhoods characterized by high rates of violent crime and low collective efficacy may provide opportunities for youth to engage in high-risk behaviors (e.g. substance use, delinquency) while also limiting positive interactions with neighbors and community members. Moreover, the constant threat of crime, regardless if it is actually experienced first-hand, may foster a constant state of fear and anxiety, experiences that have been linked with subsequent aggressive behavior (Colder, Mott, Levy, & Flay, 2000). Alternatively, youth may adopt coping strategies (e.g. staying indoors, confronting potential threats) that although might keep them safe in the short term may be maladaptive in the long term (Rasmussen, Aber, & Bhana, 2004).

Our analyses indicate that the association between indirect exposure to community violence (i.e., local homicides) and adolescents' mental health may be especially pronounced for adolescents also experiencing the contextual risks of poverty and direct exposure to violence. Adolescents' living in poor households and those who were victims of or who had witnessed violent crimes reported PCL severity score indices that were, on average, half a standard deviation higher for each SD increase in the number of local homicides. In contrast, the association was not statistically different from zero for adolescents living in non-poor households and for those who had not been directly exposed to community violence. These results may be partially-explained by the cumulative risk hypothesis, which argues that adolescents exposed to multiple stressful contexts (e.g., poverty) and adversities (e.g., direct victimization) may exhibit an increased reactivity and impaired recovery in the face of environmental stressors (Burke, Davis, Otte, & Mohr, 2005). Moreover, our findings support previous studies showing strong links between poverty and direct victimization with mental health disorders (Fowler et al., 2009; Reiss, 2013). However, it is important to note that these relations were only found for models predicting PTSD symptoms; we did not find poverty or direct victimization to be moderators of the relation between local homicides and the SRQ

index. Assuming that our measure of PTSD symptoms captures more severe mental health problems than the more general SRQ index, it may be that it is only in the context of multiple environmental stressors that exposure to local homicides elicits a relation with PTSD symptoms.

Furthermore, we found that adolescents' perceptions of neighborhood security may serve as an important buffer against the negative effects of local homicides on mental health. We found that, among youth who perceived their neighborhoods as unsafe, a one SD increase in homicides was associated with almost a ¼ of a SD increase in both the SRQ index and the PCL severity score index. However, these relations disappeared for adolescents who perceived their neighborhoods as safer. Paralleling findings from previous studies (Cooper-Vince et al., 2014; Ford & Rechel, 2012), these results highlight the importance that *subjective* perceptions may have on shaping adolescents' mental health and wellbeing despite their *objective* environment. Theoretically, these findings can be explained using two hypotheses. On the one hand, perceiving the neighborhood as insecure may be a latent stressor, increasing individual reactivity towards other stressors, whereas the opposite holds true when perceiving it as safe (Stockdale et al., 2007). On the other, perceiving the neighborhood as insecure may lead to difficult interactions with neighbors and limit outdoors activities, eliciting feelings of social isolation and mistrust, whereas perceiving it as safe may foster trust and facilitate interactions with local inhabitants, helping adolescents to cope with stressors such as living in a high-homicide area (Kim et al., 2014).

Lastly, in keeping with prior work that has failed to find evidence of social support serving as a buffer for mental health in the face of community violence (Davis et al., 2015; Paxton et al., 2004), we did not find social support to be a significant moderator of the relation between local area homicide and adolescent mental health. The lack of a significant moderation may suggest that availability of support alone is not enough to buffer the detrimental effects of living in a homicide-ridden area where adolescents may feel constantly threatened. Alternatively, it may indicate that the measure used may not accurately capture the *quality* of support (only the availability), which may be the key protective factor for adolescents' mental health.

Implications

Although the research presented here contributes to existing gaps in knowledge, additional work is needed to fully understand the complex and interacting pathways through which community violence affects adolescent development. Additional research needs to continue to explore the relative and interacting influences of living in a high-crime community versus being directly touched by crime. While this work contributes to the growing body of work that suggests both matter, better understanding of when, where, and how exposure matters is still needed. Moreover, understanding how community violence affects the *communities* in which adolescents are embedded will be critical for developing effective intervention strategies. Just as youth are affected by the violence experienced in their communities, so are many of the other individuals with whom adolescents interact and turn to for support. Understanding how adolescents' parents, teachers, and peers interpret and respond to

environmental threat will be critical as we seek to identify and develop community-level supports to adolescents touched by violence.

The ultimate intervention goal is to end community violence. However, as this goal is a complex one that will take time to achieve, researchers and practitioners need to develop strategies for supporting the youth who are most at-risk of experiencing the negative consequences of community violence and developing strategies for protecting against these negative effects. For example, our results indicate that adolescents living in poverty are more susceptible to the negative effects of community violence relative to their higher-resourced peers. As such, income-support programs which aim to raise families out of poverty may have multifaceted benefits, protecting adolescents from the adverse effects of poverty and community violence (Kilburn, Thirumurthy, Halpern, Pettifor, & Handa, 2016). There has also been increasing attention paid to the development of resources that recognize and respond to the numerous environmental stressors that thousands of children and adolescents around the world face on a daily basis, which should be further strengthened. These efforts dedicated to the building of trauma-informed schools, communities, and service-systems seek to provide supports to children touched by violence in their communities (Walkley & Cox, 2013).

Limitations and Future Directions

This study has limitations that must be discussed. First, the cross-sectional design of the data limits our capacity to infer causality in the estimated associations; it is not possible for us to rule out that omitted variables may correlate both with mental health outcomes and homicides, confounding the two effects. Longitudinal, experimental or quasi-experimental studies are needed to elucidate the causality of these findings. Second, for this study we focus exclusively on indirect exposure at the residential neighborhood, not in other contexts that adolescents may frequent, such as schools, parks, and streets. Future studies should consider the exposure at multiple contexts; in doing so, it could be possible to better understand how the pervasiveness of exposure may affect adolescents' mental health. Third, our data does not allow us to test for mechanisms that may explain how living in a homicide-ridden area may affect adolescents' mental health. Additionally, adolescents' may sub-report mental health symptoms or distress due to the stigma and shame attached to having mental disorders in Colombia (Campo-Arias & Herazo, 2014). Qualitative and mixed-methods studies, as well as additional measurement (e.g., physiological measures of stress, neuroimaging) are needed to better measure mental health and understand the mechanism underlying the relation between homicides and mental health.

Conclusion

Our findings provide important evidence of the relation between geocoded local-area homicides and detriments in adolescent mental health within the context of Bogotá, Colombia, a relatively high-crime city in a country affected by more than 50 years of civil war. Moreover, we found that this relation is especially pronounced for adolescents who were victims or witnessed a crime, and for those who lived in multidimensionally poor households, and for adolescents perceiving their residential neighborhood as unsafe. Future efforts must be done to disentangle the mechanisms that explain this relation, and to seek

strategies to foster adolescents' resilience in the face of community crime, especially for those most vulnerable.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1.Sample characteristics ($N=300$)

	M	SD	Min	Max
<i>Mental well-being outcomes</i>				
SRQ problem score ($\alpha = 0.83$)	2.06	2.96	0	16
PCL score for PTSD ($\alpha = 0.92$)	0.76	2.40	0	16
<i>Crimes (150 meters around block, twelve months before)</i>				
Homicides	0.97	1.12	0	7
Personal injuries	6.57	4.06	0	33
Theft to people	7.95	8.66	0	75
Domestic violence	4.04	3.34	0	16
Drug-related	7.99	12.89	0	126
<i>Individual and household characteristics</i>				
Sex (=1 if male)	0.48	0.50	0	1
Age	14.52	1.72	12	17
Ethnic minority ^a	0.05	0.22	0	1
Attends school	0.88	0.33	0	1
Multidimensional poverty ^b	0.13	0.33	0	1
Mother has at least secondary education	0.71	0.45	0	1
<i>Risk and protective factors</i>				
Had at least one adverse childhood experience ^c	0.52	0.50	0	1
Adversity - victim of crime	0.21	0.41	0	1
Adversity – sickness	0.05	0.23	0	1
Adversity – other stressor	0.04	0.19	0	1
Index for availability of support ($\alpha = 0.75$)	4.34	1.82	2	8
Participates in a social group	0.40	0.49	0	1
<i>Neighborhood characteristics</i>				
Police station	0.21	0.41	0	1
Park	0.37	0.48	0	1
Hospital	0.06	0.23	0	1
School	0.52	0.50	0	1
Sport Center	0.08	0.28	0	1
Perception of neighborhood security	44.44	23.47	0	100

Note.

^a Adolescent is Indigenous, Gypsy, or Afro-American.^b household is considered poor according to the MPI^c Variable that equals one if the adolescent suffered from at least one ACE.

Table 2.

Association between local homicides (150 meters around block, 12 months preceding the survey) and mental health ($N=300$)

	Mental health disorders (SD)			PTSD (SD)		
	(1)	(2)	(3)	(4)	(5)	(6)
Homicides (SD)	0.21 *** (0.06)	0.19 *** (0.06)	0.17 *** (0.06)	0.15 ** (0.06)	0.13 ** (0.06)	0.14 ** (0.06)
<i>Variables included</i>						
Crime exposure ^a	Yes	Yes	Yes	Yes	Yes	Yes
Individual – household ^b	No	Yes	Yes	No	Yes	Yes
Risk and support ^c	No	No	Yes	No	No	Yes
Neighborhood ^d	No	No	Yes	No	No	Yes
R-squared	0.04	0.07	0.17	0.07	0.07	0.26

Note. Appendix B, Table B1 presents coefficients for all covariates. Clustered-robust standard errors in parentheses.

^a Number of personal injuries, theft to people, domestic violence reports, and drug-related crimes in the 12 months before the survey within 150 meters.

^b adolescent's age, sex, ethnicity, school attendance, multidimensional poverty, and mother's education level.

^c adverse childhood experiences, direct crime victimization, exposure to other stressors, availability of support index, participation in social groups.

^d Binary variables that indicate whether there are police stations, hospitals, schools, and sport centers in the neighborhood, and adolescents' perception of security in the neighborhood.

p<0.01,

**
p<0.05,

*
p<0.1

Table 3.Moderation for SRQ – mental health disorders ($N=300$)

	Risk factors		Protective factors	
	Household poverty	Crime victimization	Sources of support	Perception of security
Homicides (SD)	0.15** (0.07)	0.18** (0.07)	0.17 (0.13)	0.23*** (0.07)
Homicides * Poverty	0.09 (0.15)			
Homicides * Victim of crime		-0.05 (0.13)		
Homicides * at least in the first SD in support index			-0.02 (0.14)	
Homicides * perceives the neighborhood as secure				-0.24* (0.13)
Control variables included ^a	Yes	Yes	Yes	Yes
R-squared	0.17	0.17	0.18	0.19

Note. Clustered-robust standard errors in parentheses.^aEstimations including the same control variables as in Table 2***
p<0.01,**
p<0.05,*
p<0.1

Table 4.Moderation for PCL – Post-traumatic stress disorders ($N=300$)

	Risk factors		Protective factors	
	Household poverty	Crime victimization	Sources of support	Perception of security
Homicides (SD)	0.03 (0.06)	0.02 (0.06)	0.25** (0.12)	0.20*** (0.07)
Homicides * Poverty	0.55*** (0.13)			
Homicides * Victim of crime		0.45*** (0.12)		
Homicides * at least in the first SD in support index			-0.14 (0.14)	
Homicides * perceives the neighborhood as safe				-0.19* (0.10)
Control variables included ^a	Yes	Yes	Yes	Yes
R-squared	0.30	0.29	0.26	0.27

Note. Clustered-robust standard errors in parentheses.^aEstimations including the same control variables as in Table 2***
p<0.01,**
p<0.05,*
p<0.1