Community Gun Violence as a Social Determinant of Elementary School Achievement

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Abstract:
The association of indirect exposure to firearm-related violence and standardized test scores among third grade elementary school children were analyzed using geospatial mapping of police department data for all gunshots in Syracuse, NY (n=2,127) and state standardized test scores from 2009-2015. Confirmed gunshots were geocoded and mapped across the city and neighborhood school catchment areas. Third grade standardized New York State test scores for English Language Arts (ELA) and math were coded as dichotomous variables of proficient and below proficient scores. State standardized test scores for ELA and math were found to be 50% lower in the elementary schools located within higher concentration gunshot areas, than in elementary schools in lower gunshot areas. Higher levels of gun violence within school catchment areas were significantly associated with higher rates of ELA and math failure ($p < .05$). These findings suggest that community violence may be an important, though under recognized, social determinant of poor school performance.

Introduction
This article examines the association between community gun violence and elementary students’ academic achievement, in Syracuse, New York as measured by NY State standardized tests. The study has grown out of an ongoing university-community collaboration among faculty and students from Syracuse University, the Syracuse Police Department, the Street Addictions Institute, Inc., the Trauma Response Team, and Mothers Against Gun Violence to address community violence. The major conceptual framework developed from the insight that indirect exposure to neighborhood violence may harm residents who live in areas with elevated rates of firearm and other forms of community violence, even when the residents are neither direct targets nor perpetrators of the violence. Previous research by our team found that among adult residents in the neighborhoods with the highest prevalence of gun violence, 52% met criteria for post-traumatic stress disorder (PTSD) and more than half of the respondents reported personally knowing five or more murder victims (Lane, Rubinstein, Bergen-Cico, et al., 2017; Jennings-Bey, Lane, Rubinstein, et al., 2016). The findings led us to examine the potential effects of indirect exposure to firearm violence on the standardized test scores of 3rd grade elementary school children. The purpose of this study is to assess the association of indirect exposure to firearm violence with elementary school children’s third grade NY State standardized test scores, including English Language Arts (ELA) and math. We begin by reviewing the relevance of this study to social work practice and the published literature on elementary school children’s exposure to violence. Subsequently we review the literature on the cognitive, emotional and neurological impact exposure to violence has on children’s development and academic achievement.

Significance for social work
This study addresses the American Academy of Social Work and Social Welfare Grand Challenge, Ensuring Healthy Development for all Youth as well as the 2015 Institute of Medicine (IOM) report Unleashing the power of prevention (Hawkins, Jenson, Catalano, et al. 2015). Both of these documents call for social workers and public health professionals to address social determinants of health conditions affecting youth. Furthermore, the IOM report recommends examining environmental, social, policy, and other potentially preventable risk factors for psychological and behavioral problems. The study described in this article fits well with the approaches advocated for in those two documents by providing evidence that living in and attending school in neighborhoods with high rates of gun violence may increase children’s risk of school failure.

Literature review
Although research examining the educational impact of exposure to violence on elementary school age children has prioritized children’s direct exposure to interpersonal violence, most studies have focused on children’s exposure to being abused in the home (Nabors, Baker-Phibbs & Woodson 2016; Paul & Eckenrode, 2015), bullied by peers (Espelage Hong, Rao & Thornberg, 2015; Mali, McDonald, Rubin, Rose-Krasnor, & Booth-LaForce 2015; Price Chiapa & Walsh 2013), exposed to sexual abuse (Goldman & Grimbeek, 2014), traumatized by mass shootings within elementary schools (Bushman, Newman, Calvert, Downey, Dredze, Gottfredson, & Romer, 2016; Downs, 2015), witnesses to elementary school age children who act out violently (Jung,
Herrenkohl, Lee, Hemphill, Heerde, & Skinner, 2015). Studies on children’s exposure to interpersonal violence show it to be associated with the children’s poorer emotional self-regulation, as well as greater risk of aggression, substance abuse, depression, anxiety, PTSD, school absenteeism, lower graduation rates, poor academic performance, and school disciplinary and criminal justice involvement (Eitle & Turner, 2002; Margolin & Gordis, 2000; Delaney-Black, Covington, Ondersma et al., 2002; Grogger, 1997; Hurt, Malmud, Brodsky, & Giannetta, 2001).

Research on children’s indirect exposure to community violence found it to be associated with potentially negative health effects, including alteration in diurnal cortisol output, decreased working memory, and poorer executive function essential to learning and self-regulation (Blair, 2002; Theall, Shirkcliff, Dismukes, Wallace, & Drury, 2017). Other studies link indirect exposure to community violence with increasing aggression, hyperactivity, and oppositional behavior (Briscoe-Smith & Hinshaw, 2006; Guerra Rowell Huesmann, & Spindler, 2003; Jaycox, Langley, & Stein, 2009). Milam and colleagues found that objectively measured community violence and perceived lack of neighborhood safety were associated with reductions in school achievement as measured by standardized exam scores for third to eighth grade students (Milam et al., 2010). Similarly, researchers in New York City found that exposure to violence the week prior to taking state standardized tests negatively affected English Language Arts (ELA) scores but not math scores among children in third to eighth grade (Sharkey, et al., 2014).

Methods

Setting

This study was conducted in the city of Syracuse, the fifth largest city in New York State, with a population of 145,170 in the 2010 U.S. Census. With 31 murders in 2016, we calculated that Syracuse’s homicide rate (21.35 per 100,000 in 2016) was higher than other Upstate New York cities (Buffalo and Rochester) and five times higher than the New York City for that year. The median 2015 household income for Syracuse residents is $31,881 and 41.8% of the city’s families with related children under age 18 have incomes that fall below the federal poverty line (U.S. Census estimate for 2015). Forty-eight percent of the 2015 population is non-White and non-Hispanic. A 2015 analysis found that Syracuse had the highest concentration of poverty among African Americans and Hispanics in the United States (Jargowsky, 2015). In Syracuse, 18 of the 34 public schools have been documented as failing by New York State Education standards (Office of Governor Andrew Cuomo, 2015). Syracuse City School District (SCSD) official graduate rate in 2015 was 54.5%, compared with the state average of 78.1% for that year.

Data sources and variable descriptions

Gunshot Data. The Syracuse City Police Department allowed us to have access to their de-identified crime database of incidents of gunshots fired between January 2009 and July 2015, inclusive. The database contains information on each incident of shots fired, which were validated by police investigation.

Elementary School Standardized Test Scores. We obtained publically available school data from the Syracuse City School District (SCSD) online report cards for each of the district’s 19 elementary schools for third grade standardized ELA and math scores for the school year 2011 to 2012. We selected that academic year to minimize the potential bias associated with the introduction of the New York State Common Core curriculum, which began in 2013. Those changes mandated new teaching and assessment methods that may have subsequently influenced student ELA and math test scores as students and teachers were adjusting to the new Common Core. ELA and math test scores declined greatly in 2013, compared to the year prior to the Common Core introduction.

New York State Department of Education evaluates the ELA and math results with four proficiency categories: level 1 is well below proficient, level 2 is below proficient, level 3 is proficient and level 4 is above proficient for the grade. We grouped test score proficiency data into two dichotomous variables: proficient for student scores of levels 3 and 4, and failing (below proficient for grade level) for students’ scores of levels 1 and 2.

Mapping gunshots and elementary school ELA and math scores.

We used Quantum GIS to plot geocoded gunshots on a map of Syracuse, an analysis that is fully described in an earlier article (Larsen et al. 2017). We then added to the map the catchment area boundary for each of the 19 elementary schools and color-coded the proportion of failing ELA and math scores by school catchment area as quintiles.
Statistical Analysis

We calculated the mean number of shots per year per school. The independent variable (IV) is mean gunshots per school catchment area. The two separate dependent variables are the percentage of ELA and math failure. We then examined the association between the indirect exposure to gunshots and state standardized test scores.

Data for third grade failure for ELA and math test scores were normally distributed. The gunshot data were not normally distributed; therefore, we conducted log-transformation of the mean number of gunshots per school catchment area. Standard analyses were run with log transformed gunshot data. Because of the small sample size, we also conducted bootstrap analyses using 1,000 resampling bootstrap calculations to confirm the findings and to reduce the bias due to sample size. The data were split into two groups; higher (above 70) and lower (below 70) number of gunshots per year in the elementary school catchment areas across the study period. All analyses were conducted in SPSS version 24.

Results

From January 2009 through June 2015, the gunshot database documented 2,098 incidents of gunshots within the city of Syracuse. The maps in Figures 1 and 2 illustrate the spatial association of gunshots and quintiles of failure rates in ELA and math third grade standardized tests. The map in Figure 1 shows gunshots and percentage of failure rate by quintile for third grade ELA (reading) scores within school catchment areas. The map in Figure 2 shows gunshots and percentage of failure rate by quintile for third grade state standardized math scores within the school catchment areas.

Forty-two percent (n=8) of the public elementary schools had an average of 219 gunshots in their catchment area (range 72-394), compared with the 11 elementary schools with 69 or fewer gunshots (average 32 gunshot episodes, range 2-62). To measure the size of the association of indirect exposure to gunshots on third grade standardized test scores we calculated the effect size between higher and lower gunshot catchment area groups using 1,000 bootstrap samples analysis to generate standard deviations and 95% confidence intervals appropriate for the small sample size.

The group of higher of gunshot catchment areas had about 50% lower proficiency third grade ELA and math scores, compared with the lower gunshot group, as shown in Table 1.
Although not as large a difference, the proportion of students receiving free lunch and students of color were also significantly different between the two groups. The analyses revealed that gunshot have a significant effect on ELA test scores, Cohens $d =$1.75, 95% CI (1.6 - 1.9) and math test scores, Cohen's $d =$1.8, 95% CI (1.7 - 1.96).

Table 1: Descriptive statistics, mean, and 95% Confidence Intervals, percent of standardized test proficiency by higher and lower gunshot catchment area groups, proportion of free lunch and students of color. Bootstrap analysis with 1,000 resampling calculations.

<table>
<thead>
<tr>
<th>2011-2012 School year</th>
<th>Schools within Higher Gunshot Catchment Areas (n=8)</th>
<th>Elementary Schools outside Lower Gunshot Catchment Areas (n=11)</th>
<th>Significance of Difference Between Higher and Lower Gunshot Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd grade percent proficient for ELA</td>
<td>17.6±7.8%</td>
<td>35.6±12.9%</td>
<td>p=.003</td>
</tr>
<tr>
<td>3rd grade percent proficient in math</td>
<td>18.8±6.3%</td>
<td>38.1±13.7%</td>
<td>p=.001</td>
</tr>
<tr>
<td>Proportion qualifying for free lunch</td>
<td>87±4%</td>
<td>66±13%</td>
<td>p=.01</td>
</tr>
<tr>
<td>Proportion students of color</td>
<td>86±10%</td>
<td>64±13%</td>
<td>p=.01</td>
</tr>
<tr>
<td>Mean number of gunshots per year</td>
<td>34±17</td>
<td>5±3.5</td>
<td>p=.01</td>
</tr>
</tbody>
</table>

Bootstrap analysis with 1,000 resampling calculations.

Figure 3 illustrates the relationship between mean number of gunshot per year by school catchment area and level of ELA and math proficiency by elementary school.

We conducted stepwise linear regression to test the association of the third-grade failure rate of ELA test scores and the mean number of gunshots per year in the elementary school catchment areas. The regression was significant (F (1, 17) 5.4 = $p < .03$ with an R$^2$ of .24) and each one-step increase in mean shots per school catchment area was associated with a 12.9 unit increase in the ELA failure rate (R$^2$=.24, $p =$ 0.03). Using the same model, we conducted linear regression analysis to examine the association between mean number of gun shots per school catchment area and math failure rate; this model was also significant (F (1, 17) 5.9 = $p \leq .03$ with an R$^2$ of .25). In this model each one-step increase in mean shots per school catchment area was associated with a
13.1 unit increase in the math failure rate ($R^2=.25$, $p = 0.03$). The results of a stepwise linear regression are presented in

Table 2: Results from linear regression models measuring the association between mean gun shots and third grade failure rates for English Language Arts and math. N= 19 schools.

<table>
<thead>
<tr>
<th>Model</th>
<th>$R^2$</th>
<th>Adjusted $R^2$</th>
<th>Std. Error of the Estimate</th>
<th>$\beta$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELA Failure Rate</td>
<td>0.24</td>
<td>0.20</td>
<td>12.9</td>
<td>0.49</td>
<td>0.03</td>
</tr>
<tr>
<td>Math Failure Rate</td>
<td>0.25</td>
<td>0.21</td>
<td>13.1</td>
<td>0.51</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Bootstrap analysis with 1,000 resampling calculations

Limitations

These analyses suggest that indirect exposure to gunshots may be an important social determinant for educational progress and attainment, but the analyses have limitations. First, our data may underestimate the occurrence of gunshots. The database of shots fired kept by the Syracuse City police department may not document all gun violence in the city. A second limitation is that due to confidentiality constraints, we were not able to base our analysis on children’s home addresses. Instead, we used publically available data, using only public elementary schools. This constraint meant the sample size for our study - 19 elementary schools - limited the types of statistical analyses that we could perform. Finally, the influence of low socioeconomic status and other risk factors likely influence educational attainment in ways not documented in our study. Despite the limitations of this study, given the few studies that have examined the effect of neighborhood violence on school achievement, our analyses suggest that more attention to this issue is warranted.

Implications for Social Work and Future Directions

The Syracuse City School District employs a social worker in each of the elementary schools, but schools in New York State have recently decreased social work positions due to budget cuts (NY State Division of the Budget, 2015; Syracuse City School District, 2017). The remaining social workers struggle to address the effect of community violence on children and their families, which in some schools appear to be overwhelming. We recommend increasing social work positions in schools and providing the social work and teaching staff training in how to work with children exposed to community violence. More generally, it is imperative that schools and communities address the impact of community violence through population-level prevention and intervention programs that address children’s traumatic stress through cognitive behavioral strategies and restorative approaches (IOM & NRC, 2013; Jaycox et al., 2009).

References


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