Urban Blight Remediation as a Cost-Beneficial Solution to Firearm Violence

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Objectives. To determine if blight remediation of abandoned buildings and vacant lots can be a cost-beneficial solution to firearm violence in US cities.

Methods. We performed quasi-experimental analyses of the impacts and economic returns on investment of urban blight remediation programs involving 5112 abandoned buildings and vacant lots on the occurrence of firearm and nonfirearm violence in Philadelphia, Pennsylvania, from 1999 to 2013. We adjusted before–after percent changes and returns on investment in treated versus control groups for sociodemographic factors.

Results. Abandoned building remediation significantly reduced firearm violence −39% (95% confidence interval [CI] = −28%, −50%; *P* < .05) as did vacant lot remediation (−4.6%; 95% CI = −4.2%, −5.0%; *P* < .001). Neither program significantly affected nonfirearm violence. Respectively, taxpayer and societal returns on investment for the prevention of firearm violence were $5 and $79 for every dollar spent on abandoned building remediation and $26 and $333 for every dollar spent on vacant lot remediation.

Conclusions. Abandoned buildings and vacant lots are blighted structures seen daily by urban residents that may create physical opportunities for violence by sheltering illegal activity and illegal firearms. Urban blight remediation programs can be cost-beneficial strategies that significantly and sustainably reduce firearm violence. (*Am J Public Health.* 2016;106:2158–2164. doi:10.2105/AJPH.2016.303434)

See also Galea and Vaughan, p. 2091.

The rate of firearm violence in the United States is estimated to be larger than that in any other developed nation, and the majority of fatal violence committed in the United States involves firearms.[1–5] As a public health issue, the costs of firearm violence in the United States are large and extend beyond the loss of life and emotional burden for affected individuals and families. Significant costs are also borne by taxpayers and society at large, with more than $48 billion per year in medical and work-loss costs alone.[6]

Combined fatal-plus-nonfatal firearm violence has been increasing in the United States over the past decade[7] and cost–beneficial interventions have been in short supply. Most attempts to reduce firearm violence in the United States have focused directly on the firearms themselves, the users of firearms, or the victims of firearm violence. The few interventions that have been shown to reduce firearm violence are often costly to sustain, politically impractical, or potentially infringe on Constitutional protections.[8–12]

Only a modicum of attention has been paid to intervening upon the context within which firearm violence occurs and the urban environments in which it thrives. It is now commonly accepted that changing the context within which health problems occur is a leading opportunity for high-impact change, often better than focusing on individuals and lifestyles.[13–17] This may also apply to firearm violence—individuals who are simply instructed to adhere to safety practices are unlikely to be successful if the unsafe context within which they find themselves day after day does not permit it.

Directly changing the contexts and environments that promote firearm violence is a potentially potent solution to explore in reducing the persistent problem of firearm violence in the United States. Such contextual changes may take the form of actual, in-situ changes to the environments themselves, an approach that may be more politically feasible, economically viable, and have a greater probability of widespread implementation.[13,18]

Cities in the United States experience a heavily disproportionate burden of the nation's interpersonal firearm violence.[19] Urban shootings are concentrated in neighborhoods stricken by poverty and neglect, and a growing body of scientific evidence suggests that blighted neighborhood environments are strongly tied to firearm violence in US cities.[9,20–25] It is very possible that directly treating aspects of these blighted environments in inexpensive ways could produce lasting reductions in urban firearm violence. However, to our knowledge, no research has yet investigated the cost benefits,

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returns on investment, and sustainability of these blight-reduction treatments on urban firearm violence.

Interventions that produce sustained reductions in firearm violence for US cities could produce reductions for the nation as a whole. Given the promising public health opportunity and potential cost benefits posed by addressing the blighted urban contexts within which firearm violence often occurs, as well as the disproportionately high and persistent burden of firearm violence in US cities, we conducted quasi-experimental analyses to determine the impacts and economic returns on investment of key urban blight remediation programs on the occurrence of firearm violence.

METHODS

We completed 2 quasi-experimental difference-in-differences analyses of specific urban blight remediation programs with regard to firearm and nonfirearm violence outcomes. One program remediated abandoned buildings[26] and the other vacant lots of land.[27] Both programs made straightforward changes to blighted structures in Philadelphia, Pennsylvania, following standardized protocols.

Abandoned Building Remediation

Philadelphia passed an ordinance in 2010 requiring owners of abandoned buildings to install working doors and windows in all structural openings and clean the facades of their buildings. One impetus for the ordinance was that traditional plywood coverings deteriorate quickly, look disheveled, signal obvious blight, and are often penetrated to allow illegal entry into abandoned buildings (Figure 1).[28] Buildings were inspected approximately once each month to assess maintenance.

The Philadelphia Department of Licenses and Inspections provided data on 2356 building addresses that were in violation of the ordinance. We enrolled all abandoned buildings that had complied with the ordinance and remediated their blighted windows and doors in our study as treatment sites (n = 676). We compared these treated buildings to a randomly selected and matched group of control buildings that had received citations but that had not been treated (n = 676). After initial 1-to-1 treatment-to-control matching, we removed and replaced any control lot within a quarter mile of its matched treatment lot to avoid treatment contamination and dilution of effect because of proximity.

We completed random matching separately within 4 sections of the city (North, Northwest, West, and South) to control for confounding variables related to geography. Within matched sets, we assigned the same treatment dates to control buildings as their matched treatment buildings so that each 1-to-1 set would have the same pre and post periods. We measured outcomes on a monthly basis around treatment and control groups for a 3-year period, from July 1, 2010, to July 31, 2013. The mean posttreatment period was 12 months.

Vacant Lot Remediation

Vacant lots are abandoned parcels of open land with no buildings on them. Philadelphia and the Pennsylvania Horticultural Society (PHS) used the city's antiblight ordinance to identify and remediate vacant lots. Vacant lots with illegal dumping, untended vegetation above a certain height, excess trash, etc. were cited as in violation of the ordinance. If the city is the owner of record, PHS can remediate forthwith. If the owner of record is a private party, then they are given 10 days to respond to the violation; consent or nonresponse allows the city to issue a legal right of entry for PHS to remediate.

Remediation involves removing trash and debris, grading the land, planting grass and trees to create a park-like setting, and installing low wooden post-and-rail fences with walk-in openings around each lot's perimeter to show that the lot was cared for, permit recreational use, and deter illegal dumping. Landscapers return approximately once each month to perform basic maintenance (Figure 1).

The PHS provided data on 4436 remediated vacant lot addresses, which we enrolled in our study as treatment sites. We compared these treated lots with a randomly selected and matched group of lots that were also in violation and eligible for treatment, but that had not been treated.[29] To choose these control lots, a master database of 49 690 untreated vacant lots was assembled from data at the Philadelphia Bureau of Revision of Taxes, Department of Licenses and Inspections, and US Postal Service. Over the study period, 3.5% of vacant lots were excluded because they had housing or other structures developed on them, had become inaccessible or unmaintainable, or were in a part of the city in which a trivial number (< 0.2%) of vacant lots had been treated.

We randomly selected and matched 3 control vacant lots (n = 13 308) to each treated vacant lot. We completed this random matching process separately within each of the 4 sections of the city to control for confounding variables related to geography. We chose the 3-to-1 ratio because at most 3 control lots per treated lot were available for random selection, without replacement, in all 4 sections of the city. Within matched sets, we assigned the same treatment dates to controls as their matched treatment lots so that each 3-to-1 comparison would have the same pre and post periods. We measured outcomes on a yearly basis, around treatment and control groups for a full 10-year period, from January 1, 1999, to December 31, 2008. The mean posttreatment period was 46 months.

Outcomes and Sociodemographic Data

We examined the effect of the 2 blight remediation programs on firearm and nonfirearm assault outcomes. The Philadelphia Police Department provided the dates and longitude–latitude coordinates for aggravated assaults, aggravated assaults involving firearms, and aggravated assaults not involving firearms from 1999 to 2013. We obtained confounding sociodemographic factors—age, education, poverty, and income—annually at the block group level for 1999 to 2013 from Geolytics Incorporated and the US Census Bureau. We defined age as median years for all residents, education as the percentage of residents aged 25 years or older with at least some college, poverty as the percentage of residents living below the federal poverty level,[30] and income as median annual household income.

We calculated point-based, distance-weighted geographic metrics for the crime

FIGURE 1—Before–After Examples of Remediation Treatments of (a) an Abandoned Building and (b) a Vacant Lot: Philadelphia, PA, 1999–2013

outcomes and sociodemographic factors in the areas surrounding each building or lot by using ArcGIS. For the abandoned buildings, we calculated these metrics monthly, and for the vacant lots, we calculated these yearly. We used the longitude–latitude locations of all assault outcomes to calculate a kernel density estimate and interpolate the assaults per square mile at the centroid of each building or lot. We assigned the value of each sociodemographic factor to the longitude–latitude location of the centroid of its block group and then we used an inverse-distance weighting calculation to interpolate the value of the sociodemographic factor at the centroid of each building or lot. In this way, crime and sociodemographic measures

that were farther away from a vacant lot or abandoned building received lower weights. These point-based GIS methods precisely and uniquely estimated the magnitude of factors at the point locations of each building and lot, avoiding the need for multilevel statistical adjustments and biases created by administrative data aggregated into polygons.[31–35]

Study Design and Analyses

We used a quasi-experimental difference-in-differences study design and analysis. We subtracted 2 differences, a pre–post and an intervention–control group difference, thereby reducing various threats to validity

and attempting to isolate the true causal effect of the intervention on the outcome.[29,36]

We first conducted unadjusted analyses and tests for multicollinearity, which was minimal (all variance-inflation factors < 4.0). We then used Poisson random-effects regression models to estimate the impact of blight remediation on crime, while controlling for sociodemographic factors.[37] Huber/White/sandwich estimators provided robust standard errors.

Each regression model included a crime outcome, Y_{it}, where i represents the units of analysis, either abandoned buildings or vacant lots, and t represents the units of time; a pre–post intervention term, $\beta_1 P_{it}$; a treatment-control status term, $\beta_2 R_{it}$; a difference-in-differences interaction term,

$\beta_3(P_{it} * R_{it})$; an indicator variable term for effects over time, $\beta_4 t$; a term indicating the size of each blighted property, either the number of building window or door openings or the square foot area of lots, $\beta_5 N_{it}$; a preperiod mean outcome interaction term to adjust for regression to the mean, $\beta_6 M_{it_0}$[38,39]; an indicator variable term for each section of the city, $\beta_7 S_i$; a series of p sociodemographic covariates, X_{it}; a group-level random-effects parameter, ξ_i; and residual error, ε_{it}[40-43]:

$$(1) \quad Y_{it} = \beta_0 + \beta_1 P_{it} + \beta_2 R_{it} + \beta_3(P_{it} * R_{it}) \\ + \beta_4 t + \beta_5 N_{it} + \beta_6 M_{it_0} + \beta_7 S_i \\ + \sum_{k=4}^{p} \beta_k X_{it} + \xi_i + \varepsilon_{it}$$

We calculated the β_3 difference-in-differences terms and interpreted them as the effect of abandoned housing or vacant lot remediation on crime. Using the previously fit regression models, we then estimated the marginal effects where $\beta_3 = 1$ and where $\beta_3 = 0$. These marginal effects were exponentiated and differenced to obtain absolute magnitudes of reduction for each outcome in the postperiod, μ_1. Absolute magnitudes of reduction were then divided by the total magnitude of occurrence for each outcome in the postperiod to obtain percentage reductions, $100 * (\mu_1 / \mu_{total})$.

The direct and indirect economic costs of crime are incurred by victims (e.g., medical expenses, property loss or damage), the criminal justice system (e.g., police, court, and incarceration costs), and society at large (including the aforementioned costs as well as other indirect costs; e.g., productivity losses resulting from criminals choosing to engage in illegal activities instead of legal activities that contribute to gross domestic product, pain, and suffering costs).[44] We calculated average annual returns on investment for each remediation program from the perspectives of taxpayers and society at large as the net benefit associated with an investment, divided by the cost of the investment.

To calculate the average annual cost savings to the taxpayer, the value assigned to each assault reflected the relevant costs incurred by the criminal justice system, and the societal value reflected all the direct and indirect costs discussed previously. Unit cost estimates were adjusted for inflation to 2014 US dollars and followed a standard approach from previous work that included tangible and intangible losses as well as cost-of-illness and jury compensation methods in calculating the costs of various criminal acts.[44] Because the mean posttreatment observation periods differed between the 2 remediation programs, we took 2 approaches to estimating returns on investment for the purpose of comparability. First, we estimated the average annual return on investment by using only the mean costs incurred in the initial remediation (i.e., the first-year costs of the program). Because the average annual cost of each program should fall over time given the relatively large initial fixed costs of remediation, this is the more conservative approach, and the primary focus of our discussion. The second approach used the average annual cost of remediation calculated over the longer observed posttreatment period of 46 months that was associated with the vacant lot program. This cost included the initial upfront cost as well as annual maintenance costs. We completed all calculations with Stata 14.0 (StataCorp LP, College Station, TX).

RESULTS

In unadjusted analyses of abandoned building remediations, we found statistically significant reductions for firearm assaults ($P < .05$), although not for all assaults or nonfirearm assaults. Unadjusted analyses of vacant lot remediations demonstrated statistically significant reductions for firearm assaults and all assault ($P < .001$), although not for nonfirearm assaults.

Regression-adjusted analyses showed that the abandoned building remediation treatment significantly reduced firearm assaults (−1.7 firearm assaults per square mile per year; 95% confidence interval [CI] = −1.2, −2.2; $P < .05$), but not nonfirearm assaults or total assaults. This absolute number of significantly reduced firearm assaults translated into −39% (95% CI = −28%, −50%; $P < .05$) fewer firearm assaults at or near abandoned buildings after they had been remediated (Tables 1 and 2).

Regression-adjusted analyses showed that the vacant lot remediation treatment also significantly reduced firearm assaults (−4.5 firearm assaults per square mile per year; 95% CI = −4.2, −4.9; $P < .001$) as well as total assaults (−5.6 firearm assaults per square mile per year; 95% CI = −4.9, −6.3; $P < .001$), but not nonfirearm assaults. These significant absolute numbers translated into −4.6% (95% CI = −4.2%, −5.0%; $P < .001$) fewer firearm assaults and −2.2% (95% CI = −1.9%, −2.4%; $P < .001$) fewer assaults at or near vacant lots after they had been remediated (Tables 1 and 2).

We followed abandoned buildings for 1 year after remediation and they had a median of 4 door or window openings. We followed vacant lots for an average of 3.8 years after remediation and they had a median area of 1078 square feet. The typical remediation costs for an abandoned building and vacant lot are $2550 and $1597, respectively, and both cost approximately $180 per year thereafter to maintain.[45]

The average annual cost offsets to the criminal justice system associated with the statistically significant reduction in firearm assaults were $16 554 (95% CI = −$11 587, −$21 151) per abandoned building remediation and $43 037 (95% CI = −$39 507, −$46 523) per vacant lot greening. Society's cost offsets for an abandoned building remediation and a vacant lot greening were $205 019 (95% CI = −$143 504, −$261 952)

TABLE 1—Reductions in Violence After Implementation of 2 Blight Remediation Strategies: Philadelphia, PA, 1999–2013

Assault Type	Abandoned Building Remediation (95% CI)	Vacant Lot Remediation (95% CI)
Firearm[a]	−1.7 (−2.2, −1.2)	−4.5 (−4.9, −4.1)
Nonfirearm[a]	−1.9 (−2.7, 1.1)	−0.6 (−1.1, 0.1)
All[a]	−3.7 (−5.2, 2.1)	−5.6 (−6.3, −4.9)
Period of sustained effect	12.0 mo	45.8 mo

Note. CI = confidence interval.
[a]Per square mile, per year.

TABLE 2—Percent Reductions in Violence After Implementation of 2 Blight Remediation Strategies: Philadelphia, PA, 1999–2013

Assault Type	Abandoned Building Remediation, % (95% CI)	Vacant Lot Remediation, % (95% CI)
Firearm	−39.2 (−50.1, −27.5)	−4.6 (−5.0, −4.2)
Nonfirearm	−13.0 (−18.5, 7.4)	−0.4 (−0.7, 0.1)
All	−19.6 (−27.7, 11.1)	−2.2 (−2.4, −1.9)
Period of sustained effect	12.0 mo	45.8 mo

Note. CI = confidence interval.

and $533 021 (95% CI = −$489 303, −$576 198), respectively.

Based on these figures and the initial cost of remediation, the first-year return on investment to taxpayers for firearm assaults averted was $5 (95% CI = $4, $7; $P < .05$) per abandoned building and $26 (95% CI = $24, $28; $P < .001$) per vacant lot. The societal first-year returns on investment for firearm assaults averted were $79 (95% CI = $55, $102; $P < .05$) for the remediation of an abandoned building, and $333 (95% CI = $305, $360; $P < .001$) for the greening of a vacant lot (Table 3). Using the longer follow-up period of 46 months that was observed for the vacant-lot program raises the average annual return–on-investment figures to $20 (95% CI = $14, $25; $P < .05$) per abandoned building and $77 (95% CI = $71, $84; $P < .001$) per vacant lot, from a taxpayer perspective, and $256 (95% CI = $179, $327; $P < .05$) per abandoned building and $968 (95% CI = $889, $1047; $P < .001$) per vacant lot, from a societal perspective, for firearm assaults.

DISCUSSION

This is the first study to our knowledge to report cost-benefit and percentage reduction estimates for urban blight remediation programs and firearm violence. Both key blight remediation programs tested here were found to be high-value, high-return strategies that significantly and sustainably reduced firearm violence. Neither program significantly reduced nonfirearm violence, suggesting that there is something unique to firearm violence that makes it especially treatable with programs that transform blighted urban environments.

Philadelphia experienced a large, statistically significant, −39% reduction in firearm violence in and around abandoned buildings that had been remediated. The city also experienced a smaller, but more statistically significant, −5% reduction in firearm violence in and around vacant lots that had been remediated. These significant reductions were sustained from 1 to almost 4 years.

Urban blight remediation is a low-cost, high-return solution to firearm violence. Simple treatments of abandoned buildings and vacant lots returned conservative estimates of between $5.00 and $26.00 in net benefits to taxpayers and between $79.00 and $333.00 to society at large, for every dollar invested. Other firearm violence prevention programs have either been unsuccessful or require more costly human resources to be active and ever-present for them to work.[8–12] Blight remediation may outperform many of these other programs in terms of value and sustainability.

Urban residents see abandoned buildings and vacant lots every day outside their homes or on their way to work or school, and have called for and led the blight remediation solutions described here. They describe these undesirable structures as, foremost, hyper-visible detractors to health, eroding their sense of community and generating trash, vermin, fear, drug abuse, prostitution, and crime.[25] Acute, biologic stress responses to seeing these blighted spaces have also been documented among residents in their communities.[46] Broken windows and collective efficacy theories also support this positing that blight visibly signals that a community is uncared-for, that incivilities and crime are tolerated, and that residents are unable to engage in shared expectations of social control over problems. As a result, unhealthy behaviors, such as firearm violence, can become sheltered and prevalent.[47–49]

Perhaps an even more compelling explanation for our findings is the actual, physical opportunities that blighted urban environments offer for firearms violence to proliferate. Abandoned buildings and vacant lots may shelter or hide individuals who participate in illegal activity. These individuals often have previous criminal records and cannot legally carry firearms, despite needing some means to settle business or other disputes. Abandoned buildings and vacant lots can thus serve as out–of-sight staging or storage areas for their illegal firearms until they are needed.[25,27] This may also help explain why firearm violence, but not nonfirearm violence, was significantly reduced after the treatment of blighted spaces.

TABLE 3—First-Year Returns on Investment From Reductions in Violence After Implementation of 2 Blight Remediation Strategies: Philadelphia, PA, 1999–2013

Assault Type	Abandoned Building Remediation, $ (95% CI)	Vacant Lot Remediation, $ (95% CI)
Firearm assaults[a]		
Taxpayer perspective	5 (4, 7)	26 (24, 28)
Societal perspective	79 (55, 102)	333 (305, 360)
Nonfirearm assaults[a]		
Taxpayer perspective	6 (−5, 9)	3 (−2, 6)
Societal perspective	86 (−50, 122)	43 (−8, 80)
All assaults[a]		
Taxpayer perspective	13 (−9, 18)	32 (28, 36)
Societal perspective	169 (−98, 240)	410 (359, 460)

Note. CI = confidence interval.
[a]Return per $1 invested.

Study Limitations and Future Directions

One concern is that an abandoned building or a vacant lot remediated in one location may displace the firearm violence it was thought to eliminate to another, nearby location. However, previous research in other cities and additional spatial displacement tests of the effects of abandoned building and vacant lot remediation conducted as part of our analyses in Philadelphia suggest that firearm violence displacement effects like this had little impact on our findings.[26,27,50,51]

Another concern is that the blight remediation strategies presented here may have led to gentrification and the displacement of low- and middle-income residents and that this may affect our findings. To be clear, the blight remediation strategies studied here were specifically chosen because they were inexpensive, scalable, and designed to be installed immediately proximal to where residents lived, oftentimes in low-income neighborhoods.[18] They were not luxury housing developments or expensive, single-location destination amenities such as upscale parks and recreation facilities.

Accompanying analyses have found property taxes to be unchanged and, if anything, reduced, after blighted properties were remediated with the inexpensive interventions described here.[27] These findings were based on differenced trends comparing treated and control spaces limiting the possibility that the effects found were attributable to gentrification, something that was further controlled by the inclusion of various sociodemographic covariates measured over time. Cities like Philadelphia have also passed municipal legislation to limit property tax increases for longtime residents in curtailing displacement because of gentrification[52] and only a very small percentage (< 5%) of the properties remediated as part of the programs described here have been developed into luxury homes or commercial businesses.[53] This suggests that the beneficial effects of these basic remediation strategies endure with few of the unwanted negative consequences of gentrification.

Although our quasi-experimental study design allowed reasonable estimates of the true changes in violence tied to the implementation of blight remediation programs, unmeasured covariates could still have confounded our findings. This may have included unaccounted differentials by which abandoned buildings and vacant lots ultimately fell into the treatment group and which did not. We carefully matched treated and control units and included a set of key covariates in our regression models to minimize this, but randomized controlled trials of abandoned building and vacant lot remediation are now warranted to fully address this limitation. Trials and additional quasi-experimental studies also should be conducted in other cities to demonstrate replicability and further investigate specific types of neighborhoods and implementation processes by which blight remediation works to reduce firearm violence.[54]

Finally, we distinguish our use of the word "blight" from previous negative connotations.[55] Our use of the word is in line with the existing federal lexicon[56] and numerous municipal ordinances. Rather than promoting unwanted relocation of residents, as has been associated with uses of the word blight in previous urban development programs,[55,57] the in situ, low-cost blight remediation strategies studied here encourage residents to remain in their homes and not to relocate (or be relocated) because their neighborhoods are chronically dilapidated and threatened by firearm violence.[25]

Conclusions

Tens of millions of vacant and abandoned properties exist in the United States. These blighted properties represent tens of billions of dollars in lost tax revenues and municipal costs. They also erode community connectedness, create stress and fear among residents, and, given the findings here, promote firearm violence. For these and other reasons, blight remediation programs have been recognized by multiple organizations interested in reducing violence and promoting urban health, including the Centers for Disease Control and Prevention, the Institute of Medicine, and the National Institutes of Health.[9,13,15,58,59]

Simple remediation of abandoned buildings and vacant lots is a high-value intervention to reduce firearm violence. By design, these remediation programs make structural improvements to the very context within which city residents are exposed on a daily basis. They involve straightforward, inexpensive, and reproducible implementation and maintenance protocols that are scalable to entire cities, ask little if anything of local residents to be sustained over time,[13,18] and allow residents to remain in their home neighborhoods without the need for expensive and unwanted relocation.[60,61] AJPH

HUMAN PARTICIPANT PROTECTION

This study was approved by the University of Pennsylvania institutional review board.

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