Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.

eMethods

Sample size

A sample size of 320 houses across 80 sites was calculated for abandoned house-specific primary aggregate event count outcomes based on 80% power and 18 month pre- and 18 month post-interventions periods, under the following assumptions: (1) two-sided α = 0.0167 (0.05/3) to control for 3 primary pairwise comparisons: house remediation vs. control; trash cleanup vs. control, and house remediation vs. trash cleanup; (2) standard deviation of the drug case counts/mile = 660 and of drunkenness cases = 14.3/mile; (3) clinically significant effect size is 0.20 (= interaction parameter/sd) leading to group-pre vs. post interaction = 132 cases/mile for drug cases/mile and 2.86 for drunkenness cases/mile; (4) no missing data since complete drug and alcohol data are available; (5) within-house time correlation (rho(t)y) for drug or alcohol data = 0.40; (6) between-house spatial correlation (rho(s)y) for event counts = 0.10; and (7) within-houses correlation (ρ_x) for -1,1 dummy variables of group and pre-post indicator variables = -0.01. We based the Cohen's effect size on a clinically meaningful effect size of 0.20, where the effect size is the interaction parameter divided by the standard deviation of the outcome.[1]

Protocol change

The study was originally designed with a 4th arm that was similar to the included trash cleanup arm but did not involve graffiti removal. This arm was dropped from the trial almost immediately after receiving the notice of grant award, and before houses were randomized, due to a budget cut. As a result, the total number of houses included in the trial was lower than the originally planned 320 houses.

Repeat Randomization

A repeat randomization procedure ensured that the clusters were balanced on multiple variables, measured from 2016 American Community Survey (ACS) estimates for the census block group in which each cluster was located, including the number of properties, median household income,

unemployment rate, race/ethnicity and average market value of homes, as well as rates of serious crime via kernel density estimates in 2016.[2] A balance threshold was set for the repeat randomization so that no differences would be significant at the p<.05 level.

Outcomes

Weapons violations included people reported as having been threatened with a gun or in possession of illegal guns; gun assaults included people being threatened with a gun, shot at, or actually shot; shooting incidents involved people actually being shot with a firearm; illegal substance trafficking and use included any police incident report for narcotics traffic, sales, or possession; and public drunkenness included arrests and misdemeanor citations for public intoxication. A single reported incident could include more than one outcome.

Difference-in-difference robustness check

We performed additional robustness checks on the parallel trends assumption by estimating a trend-adjusted difference-in-differences model that allows for separate linear trends for each study arm using the following regression model:

$$\begin{aligned} Y_{it} = \beta_0 + \beta_1 \text{Housing Remediation}_i + \beta_2 \text{Trash Cleanup}_i \\ + \beta_3 \text{Housing Remediation}_i \times t + \beta_4 \text{Trash Cleanup}_i \times t + \theta_t \\ + \alpha_{t>0} \text{Housing Remediation}_i + \gamma_{t>0} \text{Trash Cleanup}_i + \delta_{s(i)} + \xi_{c(i)} \end{aligned}$$

In this regression model the interaction terms for each trial arm and linear time trend (with coefficients β_3 and β_4, respectively) controls for overall divergent trends, while a series of month indicator terms, θ_t, captures the trend for the no-intervention study arm, and the treatment effect is estimated by the average of the $\alpha_{t>0}$ (housing remediation) and $\gamma_{t>0}$ (trash cleanup) arms in the post-treatment months only relative to the no-intervention study arm.

As a further robustness test of the difference-in-difference estimates to guard against mean reversion, we estimate a model of post treatment outcomes that includes a parameter for the pre-period (t-1) mean of each outcome according to the following regression model (eTable 3).

$$Y_{it} = \beta_0 + \beta_1 Housing\ Remediation_i + \beta_2 Trash\ Cleanup_i + \beta_3 Y_{i,t-1} + \delta_{s(i)} + \xi_{c(i)}$$

Sensitivity analyses

We collected post-intervention data around each abandoned house for 18 months beginning when the house entered the study. Houses entered the study in a staggard fashion between August 2018 and March 2019. For abandoned houses in the control arm (no work being done) and trash cleanup arm (the start of trash cleanup), all houses entered the study either in August or September 2018 and thus month 0 was at this time. For abandoned houses in the full remediation arm, month 0 occurred between August 2018 and March 2019. In other words, each house had its own start month, all of which occurred between August 2018-March 2019, and data collection ran for a subsequent 18 months. We recenter the data to have an equivalent 18-month pre-post period for all abandoned houses in the trial. Due to implementation delays, 6 of the 58 fully remediated houses were followed for 16 months in the post-intervention period.

To address the staggered rollout, we conducted a sensitivity analysis including a fixed effect for the month in which the interventions took place (eResults and eTable 4).

Given the low inclusion of privately-owned homes in the full remediation arm, we performed a sensitivity analysis restricted to just publicly owned homes to evaluate if our results differed based on type of home ownership (eResults and eTable 5).

Secondary displacement analysis

In order to evaluate if the intervention simply pushed police-reported outcomes to nearby areas, we conducted a secondary analysis of potential spatial displacement. We created 2 buffer zones around

each abandoned house and measured monthly incidents within those zones. The first proximal zone encompassed 0-330 feet (1/16th of a mile) around each abandoned house and captured the effect of the intervention on gun violence in the immediate area. The second displacement zone encompassed the area 330 to 660 feet from each abandoned house. We conducted a secondary analysis of displacement using a similar model as presented in the manuscript for reporting the main results, using the number of gun violence outcomes in abandoned house *i* in study month *t* (Y_{it}) and we estimated a Poisson regression model, as the outcome is a count (eResults and eTable 6).

eResults

Robustness checks

As seen in eFigure 1, for gun violence outcomes, the slope of each set up lines within a given outcomes are similar, consistent with the assumption of parallel trends. For substance-related outcomes, there is less consistency and the pre-intervention trends are not parallel. For public drunkenness, whose counts are very small across the board, the lines do not suggest divergent trends.

When evaluating interaction terms between treatment arms and months, results showed that gun violence outcomes are all not significant on their own or as a group (P-value from F test of their combined effect), meaning there is no difference in the pre-period time trend of these outcomes (eTable1). For the substance-related outcomes, we found significant differences in the pre-time trend differences across study arms consistent with our visual inspection. Taken together, this provides evidence of confidence in the gun violence outcomes and lower confidence in the illegal substance use outcomes.

Sensitivity Analyses

The results of the sensitivity analysis to address the staggered rollout are nearly identical to the main results, indicating no substantial impact of the staggard rollout on results (eTable 4). The results of the sensitivity analysis to evaluate only publicly owned homes showed no significant difference from the main results (eTable 5).

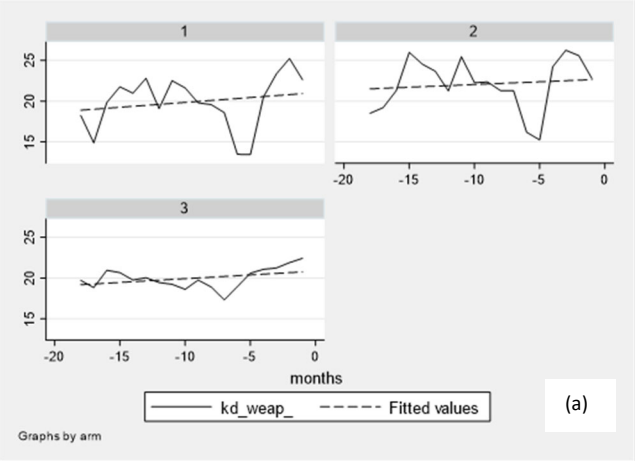
Displacement Analysis

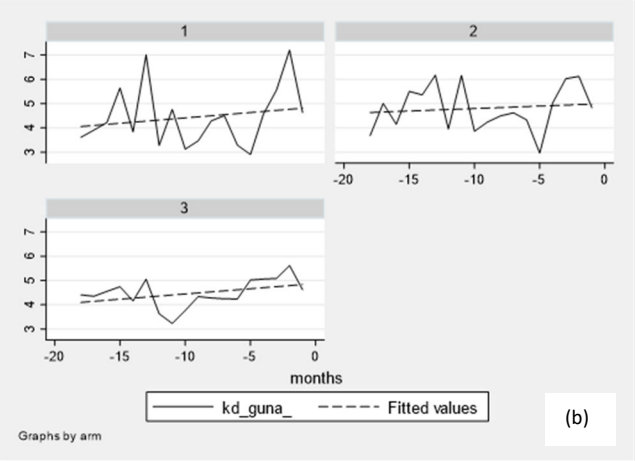
Around the housing remediation arm compared to control, the proximal zone showed a significant absolute reduction in the monthly count of weapons violations by -28.56% [IRR=0.71; 95% CI, 0.55 to 0.93; *P*=.01] and a nonsignificant absolute reduction of gun assaults of -23.37% [IRR=0.77; 95% CI, 0.44 to 1.34] and shootings of -4.8% [95% CI, -49.02 to 77.84; p = 0.88] (Table 3, eTable 6). Analysis of the displacement zone showed that weapons violations, gun assaults, and shootings were all non-

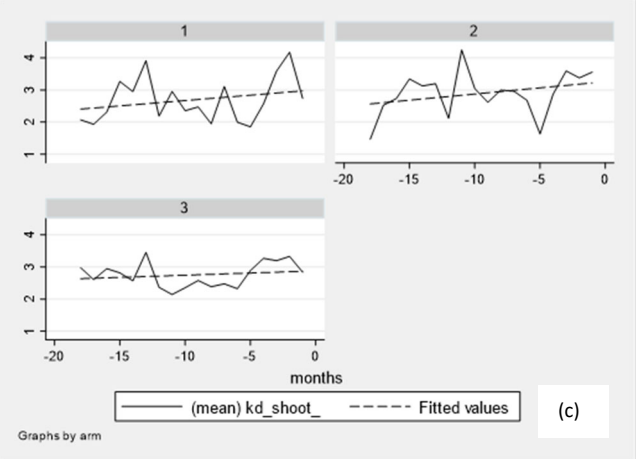
significantly lowered in the housing remediation arm relative to control, indicating that we failed to find evidence of displacement of gun violence events.

Around the trash cleanup intervention compared to control, the proximal zone showed a non-significant reduction in weapons violations, gun assaults and shootings. Similar to the housing remediation arm, no evidence of displacement was found. The displacement zone analysis similarly showed non-significant decreases across all outcomes.

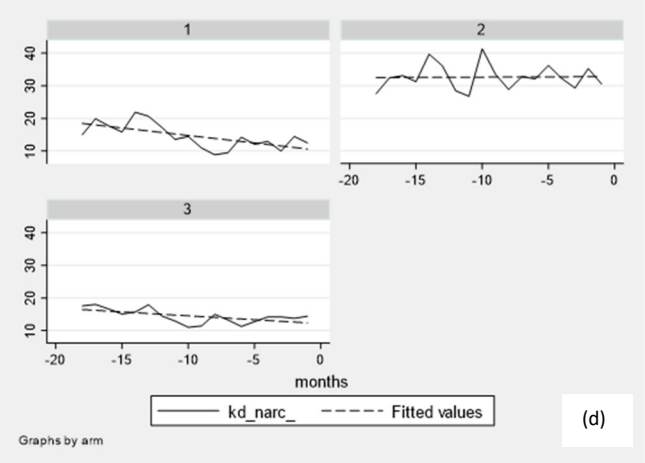
eFigure 1. Visual inspection of pre-period parallel trends. Gun violence outcomes: (a) weapons violations, (b) gun assaults, (c) shootings whereby within each graph 1, 2, and 3 are the control, trash cleanup, and house remediation arms respectively. Along the Y axis is the kernel density estimate for the outcome and along the X axis are months from 18 to 1 month pre-intervention.

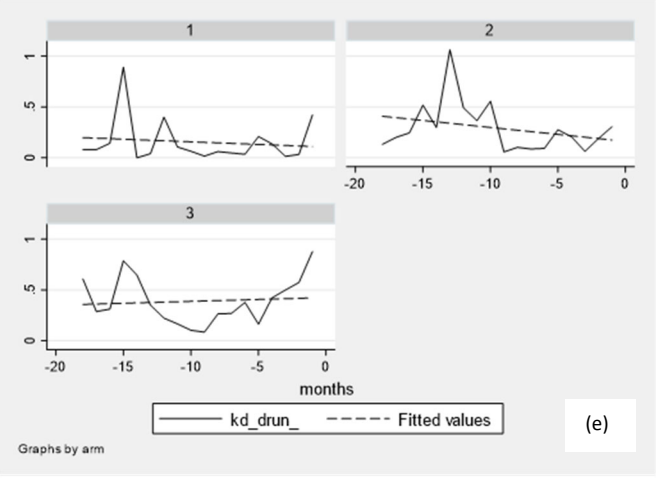




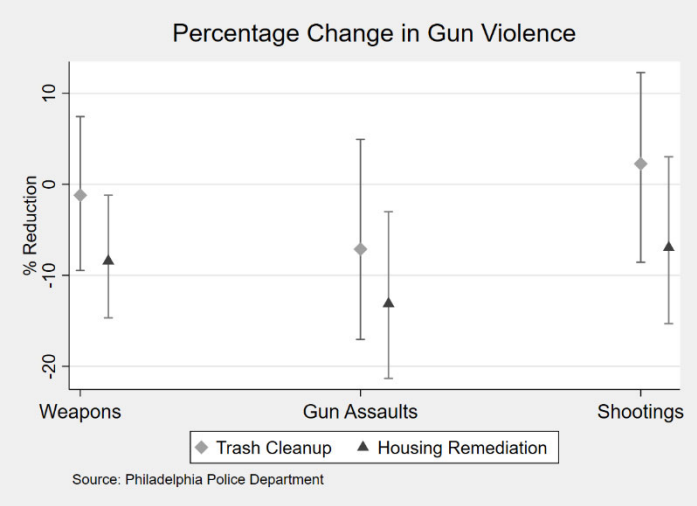


Substance-related outcomes: (d) illegal substances, (e) public drunkenness





eFigure 2. Percent reduction in three gun-violence outcomes for Housing Remediation and Trash Cleanup interventions compared to control.



eTable 1. Baseline census block group characteristics for study clusters demonstrating balance across the three trial arms including eta-squared

	Full house remediation	Trash cleanup intervention	No intervention control	η2	D_H	D_T
Abandoned House Clusters						
No.	23	20	20			
Total study houses, No.	58	93	107			
Study houses per cluster, mean (SD)	2.52 (1.20)	4.65 (1.73)	5.35 (2.25)			
Resident population, mean (SD), people	1,132.87 (540.26)	881.45 (357.22)	1,023.80 (481.88)	.048	.11	.14
Properties, No. (SD)	181.74 (50.84)	198.10 (54.49)	190.15 (52.71)	.034	.06	.14
Median household income, mean (SD)	22,029.86 (9,731.31)	24,321.00 (10,221.43)	23,055.47 (7,453.23)	.010	.05	.06
Unemployment rate, % (SD)	18.56 (10.30)	17.38 (11.63)	20.85 (11.82)	.016	.09	.14
Serious crimes[a], mean (SD), crimes	1,118.15 (509.52)	1,251.58 (559.75)	1,082.01 (383.30)	.021	.03	.16
Market value of parcels, mean (SD), $	55,953.31 (66,227.77)	49,341.47 (61,073.99)	53,633.95 (56,043.63)	.002	.01	.03
Race/ethnicity, % (SD)						
Black, non-Hispanic	76.79 (25.21)	75.43 (21.46)	87.61 (9.63)	.068	.25	.27
Hispanic	11.63 (21.39)	13.05 (19.76)	5.13 (8.15)	.037	.17	.20
White, non-Hispanic	9.12 (13.65)	7.47 (8.85)	3.69 (5.15)	.050	.25	.17
Participants						
No.	48	67	57			
Age, mean (SD), y	53.3 (13.9)	49.4 (16.9)	47.8 (15.3)	.019	.152	.034
Race/ethnicity				.017	.141	.114
Black	40 (83.3%)	60 (89.5%)	56 (98.2%)			
White	2 (4.2%)	1 (1.5%)	0			
Hispanic	6 (12.5%)	5 (7.5%)	1 (1.75%)			
Other	0	1 (1.5%)	0			
Education				.009	.010	.094
Less than high school	12 (25.0%)	15 (23.0%)	10 (17.5%)			
High School	23 (48.0%)	34 (52.3%)	32 (56.1%)			
Any college	13 (27.0%)	16 (23.8%)	15 (26.3%)			
Employment Status				0.001	.010	.046
Employed	40 (83.3%)	54 (80.6%)	48 (84.2%)			
Unemployed	8 (16.67%)	13 (19.4%)	9 (15.8%)			

[a] Serious crimes include part I violent and property crimes. Violent crimes include criminal homicide, rape, robbery, and aggravated assault. Property crimes including breaking and entering, larceny-theft, and motor vehicle theft.

D=Standardized difference of means for H (housing remediation) and T (trash cleanup) to control are either small (0.2) or between small and medium (0.5). η2= eta-squared or the proportion of the variance explained between treatment arms shows small ($\eta^2 = 0.01$) effect size differences for all the variables except % Black residents, which shows a medium ($\eta^2 = 0.06$) effect size difference.[3]

SD = standard deviation

eTable 2. Test of parallel pre-intervention trends.

	Full house remediation x months	**Trash cleanup x months**	
	Coefficient [95% CI]	Coefficient [95% CI]	P(df=2)
Weapons Violations	-0.0270 [-0.102,0.0476]	-0.0527 [-0.118,0.0122]	0.280
Gun Assaults	-0.00120 [-0.0299,0.0275]	-0.0240 [-0.0489,0.0008]	0.126
Shootings	-0.0198 [-0.0411,0.00156]	0.00512 [-0.0135,0.0237]	0.0727
Illegal substance	0.221** [0.0720,0.369]	0.476*** [0.347,0.605]	0.000
Public Drunkenness	0.00889 [-0.00212,0.0199]	-0.008 [-0.0182,0.0009]	0.009

Models control for arm, months, and section of city
P-value from F-test of arm*pre-months interactions
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

eTable 3. Robustness check to guard against mean reversion

	Full house remediation vs. no intervention control	P value	**Trash cleanup vs. no intervention control**	P-value
	Coefficient [95% CI]		Coefficient [95% CI]	
Weapons Violations	-2.16 [-3.21, -1.10]	<.001	-1.10 [-2.30, 0.10]	0.07
Gun Assaults	-0.93 [-1.43, -0.43]	<.001	-0.57 [-1.24, 0.10]	0.09
Shootings	-0.40 [-0.72, -0.08]	0.01	-0.18 [-0.47, 0.12]	0.24
Illegal Substance	1.66 [-3.07, 6.39]	0.49	3.65 [-1.74, 9.03]	0.19
Public Drunkenness	-0.13 [-0.53, 0.28]	0.54	0.23 [-0.21, 0.67]	0.31

eTable 4. Sensitivity analysis including calendar month as a fixed effect to account for staggered rollout of intervention timeline for abandoned house remediation and trash cleanup clusters compared to no-intervention control clusters on gun violence and substance-related outcomes

Outcome	Full house remediation (cluster n=23, house n=49) vs. control (cluster n=20, house n=69)		Trash cleanup (cluster n=20, house n=46) vs. control (cluster n=20, house n=69)	
	Kernel density analysis, N=5,896			
	Coefficient [95% CI]	P value	Coefficient [95% CI]	P value
Weapons violations	-1.93 [-3.59, -0.27]	0.02	-0.30 [-2.56, 1.97]	0.80
Gun assaults	-0.76 [-1.36, -0.16]	0.01	-0.44 [-1.17, 0.30]	0.23
Shootings	-0.23 [-0.56, 0.09]	0.16	0.08 [-033, 0.50]	0.70
Illegal substance	0.86 [-2.10, 3.82]	0.57	6.76 [-5.12, 18.65]	0.27
Public drunkenness	-0.20 [-0.71, 0.31]	0.45	0.23 [-0.64, 1.10]	0.61

eTable 5. Sensitivity analysis demonstrating difference-in-differences results for abandoned house remediation and trash cleanup clusters compared to no-intervention control clusters on gun violence and substance-related outcomes only for publicly owned properties

Outcome	Full house remediation (cluster n=23, house n=49) vs. control (cluster n=20, house n=69)		Trash cleanup (cluster n=20, house n=46) vs. control (cluster n=20, house n=69)	
	Kernel density analysis, N=5,896			
	Coefficient [95% CI]	P value	Coefficient [95% CI]	P value
Weapons violations	-1.91 [-3.48, -0.35]	0.02	-0.67 [-2.75, 1.46]	0.53
Gun assaults	-0.76 [-1.29, -0.24]	0.004	-0.38 [-1.02, 0.27]	0.25
Shootings	-0.16 [-0.36, 0.03]	0.11	0.02 [-0.17, 0.22]	0.81
Illegal substance	1.03 [-1.57, 3.62]	0.44	1.91 [-1.01, 4.83]	0.20
Public drunkenness	-0.35 [-0.84, 0.14]	0.16	-0.11 [-0.65, 0.43]	0.69

eTable 6. Unadjusted total counts of outcomes during the pre- and post- intervention time periods for each trial arm in the proximal and displacement zones, and absolute change from pre- to post- intervention time periods.

Outcome	Full house remediation (cluster n=23, houses n=58)			Trash Cleanup intervention (cluster n=20, houses n=93)			No intervention control (cluster n=20, houses n=107)		
	Pre N=1,044	Post N=1,036	Change	Pre N=1,674	Post N=1,674	Change	Pre N=1,926	Post N=1,926	Change
	Secondary displacement analyses								
	Proximal zone (0-330 feet), total count								
Weapons Violations	389	337	-52	691	720	29	619	757	138
Gun assaults	118	89	-29	193	170	-23	188	187	-1
Shootings	59	73	14	96	118	22	119	156	37
Illegal substance	187	116	-71	1200	2631	1431	592	729	137
Public drunkenness	0	8	8	3	15	12	6	42	36
	Displacement zone (330-660 feet), total count								
Weapons Violations	914	952	38	1869	1985	116	1920	2105	185
Gun assaults	204	232	28	522	491	-31	528	635	107
Shootings	132	141	9	264	306	42	314	422	108
Illegal substance	683	664	-19	3313	4437	1124	1522	1482	-40
Public drunkenness	12	56	44	8	82	74	18	119	101

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3. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Routledge Academic; 1988.