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Modifiable Neighborhood Features Associated With Adolescent Homicide

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Abstract

IMPORTANCE—Homicide is a leading cause of adolescent mortality. To our knowledge, relatively little has been studied in terms of the association between environmental neighborhood features, such as streets, buildings, and natural surroundings, and severe violent injury among youth.

OBJECTIVE—To assess associations between environmental neighborhood features and adolescent homicide in order to identify targets for future place-based interventions.

DESIGN, SETTING, AND PARTICIPANTS—Population-based case-control study conducted in Philadelphia, Pennsylvania, from April 15, 2008, to March 31, 2014. We identified adolescents who died by homicide at 13 to 20 years of age from 2010 to 2012 while residing in Philadelphia. We used incidence-density sampling and random-digit dialing to recruit control participants ages 13 to 20 years matched on sex and indoor-outdoor location at the time of each index case participant's homicide.

EXPOSURES—To obtain environmental data about modifiable features that were present in the immediate surroundings of our case and control participants, blinded field researchers used standardized techniques to photograph case and control participant outdoor locations. Photographic data were stitched together to create 360° panoramic images that were coded for 60 elements of the visible environment.

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Study concept and design: Culyba, Richmond, Fein, Hohl, Branas.
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MAIN OUTCOME AND MEASURE—Adolescent homicide.

RESULTS—We enrolled 143 homicide case participants (mean [SD] age, 18.4 [1.5] years) and 155 matched control participants (mean [SD] age, 17.2 [2.1] years) who were both outdoors at the time of the homicide. In adjusted analyses, multiple features of Philadelphia streets, buildings, and natural surroundings were associated with adolescent homicide. The presence of street lighting (odds ratio [OR], 0.24; 95% CI, 0.09-0.70), illuminated walk/don't walk signs (OR, 0.16; 95% CI, 0.03-0.92), painted marked crosswalks (OR, 0.17; 95% CI, 0.04-0.63), public transportation (OR, 0.13; 95% CI, 0.03-0.49), parks (OR, 0.09; 95% CI, 0.01-0.88), and maintained vacant lots (OR, 0.17; 95% CI, 0.03-0.81) were significantly associated with decreased odds of homicide. The odds of homicide were significantly higher in locations with stop signs (OR, 4.34; 95% CI, 1.40-13.45), security bars/gratings on houses (OR, 9.23; 95% CI, 2.45-34.80), and private bushes/plantings (OR, 3.44; 95% CI, 1.18-10.01).

CONCLUSIONS AND RELEVANCE—Using a population-based case-control design, we identified multiple modifiable environmental features that might be targeted in future randomized intervention trials designed to reduce youth violence by improving neighborhood context.

Violence changes the life course of far too many young people in the United States. Homicide, the most extreme consequence of interpersonal violence, led to 2043 deaths among adolescents ages 13 to 20 years in 2013,[1] with the highest incidence concentrated in urban settings and among African American youths.[2] Medical advances have reduced assault case-fatality rates, but declines over the last 25 years have stagnated as we reach the limits of what postinjury medical care can do to save critically injured youths.[2]

Youth violence is as complex as it is pervasive and requires research that addresses individual-, family-, community-, and society-level risk factors.[3] Prevention programs that intervene on violence-promoting societal factors, such as poverty and inequities in education, could produce a very high level of population effect, while offering major savings to the US medical system.[4] Although such programs are absolutely necessary to set in motion, they are also complicated, at times controversial, and may take generations to produce sustained results. Research has also shown that, while sometimes effective, programs targeting individual factors, including high impulsivity, delinquent behavior, and substance use, often require expensive and continuous investments to maintain long-term behavior change for small numbers of youths. These programs may thus have limited effect, sustainability, and benefit to the broader population of youths.[2,4-6]

Modifying environmental risks for violence offers an intervention point between extensive but ambitious socioeconomic interventions and less sustainable individual-level interventions. Structural deterioration, abandonment, and social disorder may heavily influence the occurrence of crime and violence.[7,8] A growing evidence base demonstrates that inexpensive revitalization of blighted urban land, buildings, and business districts, as well as remediation of structural concerns—poor street lighting, limited transportation access, and limited exposure to nature—may be key in improving health and reducing violence.[2,5,6,9-13]

Adolescence includes tremendous physical, developmental, and social change, which may fundamentally alter the way youths assess risk and navigate their environments. Understanding the unique influences of modifiable environmental factors on adolescent homicide is a critical first step in designing place-based interventions for youth violence prevention. To address this, we conducted a population-based, case-control study among Philadelphia, Pennsylvania, adolescent residents aged 13 to 20 years in which the environments of case and matched control participants were photographed and quantified via standardized pictometric protocols[14] to assess associations between modifiable environmental features and adolescent homicide.

Methods

We used incidence-density sampling to recruit participants for a population-based case-control study. This study was approved by the University of Pennsylvania and the City of Philadelphia institutional review boards. We obtained verbal consent for participation from respondents aged 18 years and older and verbal consent from a parent or guardian and assent from those aged 13 to 17 years.

Participants and Matching

Case participants died by homicide at 13 to 20 years of age and were Philadelphia County residents whose homicide occurred in Philadelphia between 2010 and 2012. Each case participant was identified on the day in which the homicide occurred by data coordinators who established an adolescent homicide case participant surveillance system with the Philadelphia Office of the Medical Examiner and the Philadelphia Police Department. Information on case participants, including homicide date and time, age and sex, and Philadelphia resident status, was forwarded to an independent survey research firm (DataStat Inc) to recruit matched control participants.

Through random-digit dialing, we recruited 13- to 20-year-old control participants from households located within Philadelphia County using incidence-density sampling to recruit a population-based sample of Philadelphia youths.[15-17] By doing so, we recruited control participants from the same source population (Philadelphia County) that gave rise to the case participants. A ±3-hour caliper match surrounding the homicide time was used to pair-match control participants to case participants to mitigate the effect of unmeasured confounders related to time and seasonal variation.[17-20] Control participants were also pair matched to case participants by sex and indoor vs outdoor location at the time of each case participant's homicide because high levels of mismatch were predicted in these 2 variables prior to recruitment.[18]

The current analysis includes all adolescent homicide case participants who were injured outdoors and their matched control participants. The recruitment of case and control participants at a 1:1 sampling ratio was based on a priori power calculations. However, to quickly identify control participants, there were several instances in which multiple interviewers simultaneously completed control participant interviews. This resulted in 13 case participants who had more than 1 matched control participant, all of whom were retained in the analysis.

Data Collection and Sources

Detailed information about case participants was obtained from the Philadelphia Child Death Review Case Reporting System in the Office of the Medical Examiner. This review is composed of an interdisciplinary team of municipal and private member organizations that jointly compile records for all deaths of Philadelphia children from birth through 21 years including information on the decedent, his or her family, and contextual characteristics. The Philadelphia Police Department provided the address location and circumstances of each homicide and the case participant's arrest history. Toxicology results provided by the Medical Examiner's Office established case participants' substance use at the time of the homicide.

Control participants provided information on their demographic characteristics, delinquency history, and substance use in a structured telephone interview conducted at enrollment. Interviewers used prompts to help control participants accurately recall detailed information about their address location and substance use at the time of their matched case participants' homicide. To minimize recall bias, control participant interviews were conducted within a median time of 11 days of their matched case participants' homicide.

The population-based random sample survey was fielded to rapidly interview (within 1-2 weeks) a representative sample of a specific group of hard-to-reach study participants (ages 13 to 20 years) who were outdoors in a specific city (Philadelphia) within a specific time window (homicide time of a specific case participant). To maximize participation and avoid nonresponse and other selection biases, DataStat used multiple recruitment strategies.[18,21] Based on American Association for Public Opinion standard formulae, the cooperation rate for control participants was 73.4% and the response rate was 52.3%,[22] which are as high or higher than rates achieved by other representative, random-sample surveys.[23-26]

Neighborhood-level potential confounders were geographically coded using latitude and longitude centroid points of Census tracts (household income and unemployment) and block groups (race/ethnicity) from 2010 US Census data. We used annual Philadelphia Police Department crime location data to create a geographically coded summary variable of total crimes per square mile (summing aggravated assaults, burglaries, robberies, disorderly conduct, theft, vandalism, illegal dumping, public drunkenness, and narcotic manufacture, possession, and sales). Case and control participants were assigned measures of their exposure to each neighborhood-level confounder based on homicide and matched control locations and the magnitude of the environmental factors surrounding them using inverse distance weighting (Census variables) and kernel density (crime) calculations. Census tracts and block groups, created as administrative boundaries, often do not represent the geographic scale best suited for particular studies of environmental effects.[27,28] Using inverse distance weighting and kernel density measures, which are continuous and boundary free, allowed us to assign each case and control participant their own unique neighborhood exposure based on their exact location. This procedure avoids aggregation effects and does not require multilevel adjustments.[29]

To obtain microspatial data about modifiable features that were present in the immediate environments of our case and control participants, trained field staff conducted audits of all case and control participant address locations. Field staff were blinded to case/control participant status and were purposely delayed by 1 to 2 weeks in their field audits to avoid other official investigations (eg, by police). Full, 360° sets of photographs were taken from the street corner closest to each case participant (corresponding to the homicide address) and control location using a standardized field protocol. Photographs were uploaded and stitched into 360° high-resolution panoramas using Microsoft Photosynth software (eFigure 1 in the Supplement). Trained coders blinded to case/control participant status coded all panorama photographs for 60 visible elements of the built and social environments using a detailed code book (eTable in the Supplement). Photographs were assessed by multiple coders and any discrepancies were resolved by consensus.

Statistical Methods

We separately modeled associations between each environmental exposure of interest and adolescent homicide. We used conditional logistic regression to produce odds ratios (ORs) that accounted for matching on sex, hour of the day, and outdoor status using Stata version 13 (StataCorp). Fully adjusted ORs adjusted for individual characteristics, including age in years (linear), race (black, white, or other), history of arrest (yes/no), and alcohol and drug use at the time of the homicide (yes/no), and neighborhood characteristics defined by inverse distance weighting/kernel density calculations, including median household income (linear), unemployment percentage (linear), percentage who were black (linear), percentage who were Hispanic (linear), and crimes per square mile (linear). A robustness check to assess alternative confounder forms (eg, quadratic) was not statistically significant and overall findings were unchanged. We examined stratified 2 × 2 tables, initial and fully adjusted standard errors to identify concerns related to sparse data and collapsed multicategory classifications when appropriate. We tested all models for collinearity and variance inflation factors were less than 2.5 in all instances. Statistical tests were 2-tailed, and $P < .05$ was used as the threshold for significance.

Results

A total of 143 homicide case participants and 155 matched control participants were included. The median difference between case time and control time was 53.5 minutes (interquartile range, 18.5-104 minutes). Fifty-four percent were matched between 0 and 59 minutes, 26% between 60 and 119 minutes, 18% between 120 and 179 minutes, and 2% at longer than 180 minutes. One hundred of the homicides occurred between 7 PM and 5 AM. On average, the mean control times were further from midnight than the case participant times by 11.3 minutes for these nighttime homicides.

Case participants tended to be older (18.4 vs 17.2 years), were more likely to be black (87.4% vs 55.5%), to have a history of arrest (67.1% vs 14.8%), and to have used drugs at the time of the homicide (17.5% vs 4.5%) (**Table 1**). Case locations had higher crime rates (1321.6 vs 1044.5 crimes per square mile) and lower percentage who were Hispanic (5.1% vs 6.4%). There were no significant differences in ethnicity, alcohol use, median household income, unemployment percentage, or percentage who were black. On average, 0.9% of individual characteristics and 1.7% of neighborhood characteristics were missing. Twelve case and 13 control participants (8%) were missing elements of the pictometry data. Case locations tended to cluster in high-risk neighborhoods, whereas control locations demonstrated geographic coverage of Philadelphia County, appropriately reflecting population-based sampling (eFigure 2 in the Supplement).

Association Between Street Conditions and Adolescent Homicide

In fully adjusted analyses, multiple features of Philadelphia streets were associated with adolescent homicide (**Table 2**). The presence of street lighting (OR, 0.24; 95% CI, 0.09-0.70), illuminated walk/don't walk signs (OR, 0.16; 95% CI, 0.03-0.92), painted marked crosswalks (OR, 0.17; 95% CI, 0.04-0.63), and public transportation visibility/ availability (OR, 0.13; 95% CI, 0.03-0.49) were all significantly associated with decreased odds of homicide. Stop signs were associated with significantly increased odds of homicide (OR, 4.34; 95% CI, 1.40-13.45). Associations between homicide and trash, sidewalk condition, and street type were not significant in adjusted analyses.

Association Between Building Conditions and Adolescent Homicide

Few features of building conditions were associated with adolescent homicide (**Table 3**). The odds of homicide were significantly higher in locations with security bars on houses (OR, 9.23; 95% CI, 2.45-34.80). The odds of homicide was 4.71 times higher in locations with row homes, although the 95% CI crossed just beyond 1 (95% CI, 0.99-22.47). Point estimates for the association between property type and homicide were less than 1 for commercial and mixed commercial/residential areas compared with residential areas, but adjusted estimates did not reach statistical significance. While the direction and magnitude of associations between homicide and other building features suggested both direct (building condition, broken windows, and visible furniture) and inverse (housing over store-fronts, pull-down metal fencing, security fences, and murals) associations, none of these associations were statistically significant in fully adjusted models.

Association Between Natural Surroundings and Adolescent Homicide

Several features of natural surroundings were associated with adolescent homicide in fully adjusted analyses (**Table 4**). The presence of a park was associated with significantly lower odds of homicide (OR, 0.09; 95% CI, 0.01-0.88). The odds of homicide were significantly lower in locations with a maintained vacant lot (OR, 0.17; 95% CI, 0.03-0.81). Private bushes/plantings were associated with 3.44 times higher odds of homicide (95% CI, 1.18-10.01). Playgrounds, neglected vacant lots, trees, and public plantings were not significantly associated with homicide.

Discussion

Using a population-based case-control design, we examined associations between environmental features and adolescent homicide in Philadelphia. After controlling for individual and neighborhood characteristics, multiple modifiable features of streets, buildings, and natural surroundings were significantly associated with adolescent homicide, highlighting potential targets for future place-based interventions.

Homicide stems from a complex interplay of individual, relational, and environmental factors. Multiple theories concur with our findings. In framing these findings, the observed associations between homicide and the built environment support a nuanced view of broken windows theory, a common framework for thinking about the effect of neglected urban environments. This theory suggests that dilapidated public spaces and visible signs of disorder become part of a larger contagion effect that creates more disorder and ultimately crime, leaving communities disempowered to intervene.[30] Our initial analyses found significant associations between homicide and signs of physical disorder, such as trash, poor sidewalk condition, and broken windows. Yet none of these associations maintained statistical significance in fully adjusted models. This is in contrast to research in adult populations that demonstrates significant associations between vacant properties and aggravated assault[8] and simple building remediation, such as replacing broken windows, and reductions in violence.[10] Given the growing evidence that associates physical disorder and crime[8,10,31] and the ORs observed in the current study, future research should continue to assess the association and identify potential mediators between physical disorder and adolescent homicide.

A related, but more recent theory, suggests that busy streets and mixed residential-commercial urban spaces create vibrant community contexts that encourage interactions and social connections among residents and facilitate social control, thus reducing crime.[13] This theory suggests that features of the built environment can directly shape residents' perceptions of safety and willingness to interact and monitor their neighborhoods. Built features that encourage higher street activity serve as deterrents to crime. Street lights, illuminated walk/don't walk signs, marked crosswalks, and stops for public transportation are all environmental features that encourage busy streets through increased pedestrian activity and community interaction and were inversely associated with adolescent homicide in our analyses. In contrast, stop signs, which were associated with higher odds of homicide, may be markers of less busy settings in urban residential neighborhoods.

Urban land use and remediation offer additional modifiable factors that may influence the association between the built environment and youth homicide. Prior research has demonstrated associations between the greening of vacant lots and reductions in violent crime.[9,32-35] The current study corroborates and supports this research—we found significant associations between well-maintained vacant lots and decreased odds of homicide. The presence of parks was also associated with a reduction in the odds of homicide, suggesting that the benefit of municipal green spaces extends beyond opportunities for physical and leisure activity.[36] Parks and other green spaces encourage public gatherings and informal guardianship and have also been shown to mitigate psychological precursors to violence such as mental fatigue.[37] Although we found no association between locations with trees or public plantings and homicide, the odds of homicide were significantly increased in locations with private plantings. Private plantings may obscure visibility along sidewalks and create opportunities for crime, potentially explaining the observed association.[36,38] The findings related to maintained vacant lots and green space hold promise as targets for future place-based interventions. Researchers using this urban revitalization strategy should consider studying homicide reduction as a key health outcome.

Limitations and Strengths

The current study had several limitations. Despite rigorous methods to recruit a representative population-based sample, selection bias among eligible control participants could have affected our results. While we adjusted for demographic differences between case and control participants and accounted for multiple potential individual and neighborhood confounders, it is possible that unmeasured individual, social, and contextual factors that we were unable to include may have influenced our findings. Owing to sparse data concerns, we also examined each of our environmental factors separately and were unable to draw conclusions about the potentially synergistic effects of multiple co-occurring environmental factors. Even in doing this, the number of case and/or control participants within certain strata was sometimes small and may have led to unstable estimates with wide confidence intervals in some of the associations we report here. Although it was possible that some environmental features might have changed between the index homicide and pictometry dates, we analyzed features of the built environment that likely changed little, if any, over this interval that was only a few weeks long. We also selected the corner closest to the index case/control location to protect participant confidentiality, but this may have resulted in up to a half block distance misclassification. Given the relatively short distance of Philadelphia city blocks, most features of the built environment that we coded were in view regardless of this minor distance misclassification. Finally, and very importantly, case-control studies are observational by design and we have endeavored not to infer causation based on the associations observed here.

The key strengths of our study included a population-based case-control design with incidence-density sampling and detailed assessment of environmental features. Prior research has suggested that a more nuanced appreciation of specific features in the urban environment may be critical to our understanding of environmental risk and protective factors that adults and children encounter on a daily basis.[10,39,40]

Future Directions

Based on our findings and prior research, several features emerged for consideration in future experimental or quasi-experimental studies of interventions to reduce adolescent violence. These features include lighting, pedestrian infrastructure, public transportation, parks, and remediated vacant spaces. Business improvement districts, vacant lot greening, enhanced sanitation, security, and usability of public spaces have all been associated with decreases in violent crime,[9,11] coincide with our findings here, and may be promising avenues for future interventions that prevent broken windows and promote busy streets in urban areas.[12] Community-based qualitative research and participatory methods may also offer more in-depth explanations of the causal mechanisms underlying these associations and any subsequent interventions.

Conclusions

Using a novel population-based case-control design, this study provides valuable new information and quantitative findings regarding the associations between features of the immediate, surrounding environment and adolescent homicide. We identified multiple modifiable factors that can potentially be targeted in future randomized intervention trials to investigate ways to reduce youth violence by improving neighborhood context.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Points

Question

What modifiable features of streets, buildings, and natural surroundings are associated with adolescent homicide?

Findings

A population-based, case-control study of Philadelphia adolescents ages 13 to 20 years used pictometry to assess features at homicide and control locations. Street lights, illuminated walk/don't walk signs, painted marked crosswalks, public transportation, parks, and maintained vacant lots were associated with significantly decreased odds of homicide. Stop signs, security bars on houses, and private bushes/plantings were associated with significantly increased odds of homicide.

Meaning

Modifiable environmental features identified here should be considered for future trials of place-based interventions to reduce youth violence.

Table 1

Individual and Neighborhood Characteristics of Case and Control Participants

Characteristic	Participants, No. (%) Case (n = 143)	Control (n = 155)	*P* Value[a]
Individual			
Age, mean (SD), y	18.4 (1.5)	17.2 (2.1)	
13-14	4 (2.8)	24 (15.5)	<.001
15-16	11 (7.7)	32 (20.6)	
17-18	51 (35.7)	46 (29.7)	
19-20	77 (53.8)	53 (34.2)	
Sex			
Male	137 (95.8)	148 (95.5)	.89
Female	6 (4.2)	7 (4.5)	
Race			
White	16 (11.2)	60 (38.7)	<.001
Black	125 (87.4)	86 (55.5)	
Other	2 (1.4)	7 (4.5)	
Ethnicity			
Hispanic	13 (9.1)	24 (15.5)	.13
Non-Hispanic	122 (85.3)	129 (83.2)	
History of arrest			
None	47 (32.9)	130 (83.9)	<.001
≥1	96 (67.1)	23 (14.8)	
Substance use at time of homicide			
Alcohol use	12 (8.4)	10 (6.5)	.54
Drug use	25 (17.5)	7 (4.5)	<.001
Neighborhood			
Household income, median (IQR), $	33 872 (26 444-47 030)	36 395 (30 271-46 619)	.14
Unemployment, median (IQR), %	2.7 (2.2-3.8)	3.1 (2.3-4.4)	.10

	Participants, No. (%)		
Characteristic	**Case (n = 143)**	**Control (n = 155)**	***P* Value[a]**
Black, median (IQR), %	52.6 (21.3-80.0)	51.0 (25.3-75.9)	.83
Hispanic, median (IQR), %	5.1 (3.5-7.6)	6.4 (3.7-14.8)	.007
Total crimes/square mile, median (IQR)	1321.6 (1078.7-1724.8)	1044.5 (408.1-1594.91)	<.001

Abbreviation: IQR, interquartile range.

[a]Calculated using Wilcoxon rank-sum test for age, median household income, unemployment percentage, percentage of that population who are black, percentage of the population who are Hispanic, and total crimes and using χ^2 test for race, sex, ethnicity, history of arrest, and substance use at time of homicide.

Table 2

Street Conditions and Adolescent Homicide

Characteristic	Participants, No. (%) Homicide Case	Control	OR (95% CI)[a]	Fully AOR (95% CI)[b]
Trash				
None/minimal	32 (22.4)	74 (47.7)	1 [Reference]	1 [Reference]
Moderate/heavy	98 (68.5)	69 (44.5)	3.34 (1.83-6.12)	1.29 (0.49-3.40)
Street lights				
None	92 (64.3)	56 (36.1)	1 [Reference]	1 [Reference]
≥1	39 (27.3)	87 (56.1)	0.26 (0.14-0.48)	0.24 (0.09-0.70)
Illuminated walk/don't walk signs				
None	124 (86.7)	104 (67.1)	1 [Reference]	1 [Reference]
≥1	7 (4.9)	39 (25.2)	0.18 (0.07-0.45)	0.16 (0.03-0.92)
Painted crosswalks				
None	32 (22.4)	27 (17.4)	1 [Reference]	1 [Reference]
≥1	99 (69.2)	116 (74.8)	0.62 (0.32-1.20)	0.17 (0.04-0.63)
Stop signs				
None	48 (33.6)	92 (59.4)	1 [Reference]	1 [Reference]
≥1	83 (58.0)	51 (32.9)	2.71 (1.55-4.74)	4.34 (1.40-13.45)
Public transportation available/visible				
No	95 (66.4)	71 (45.8)	1 [Reference]	1 [Reference]
Yes	36 (25.2)	71 (45.8)	0.39 (0.21-0.71)	0.13 (0.03-0.49)
Sidewalk condition				
Excellent	20 (14.0)	44 (28.4)	1 [Reference]	1 [Reference]
Good	47 (32.9)	57 (36.8)	1.71 (0.80-3.65)	2.32 (0.62-8.65)
Fair	49 (34.3)	31 (20)	2.91 (1.44-5.90)	1.21 (0.37-4.04)
Poor	15 (10.5)	9 (5.8)	3.23 (1.04-9.99)	0.63 (0.13-3.28)
Street type				
1 lane, 1 way	47 (32.9)	32 (20.7)	1 [Reference]	1 [Reference]

Characteristic	Participants, No. (%) Homicide Case	Participants, No. (%) Control	OR (95% CI)[a]	Fully AOR (95% CI)[b]
2 lane, 1 way	9 (6.3)	16 (10.3)	0.37 (0.12-1.15)	0.16 (0.02-1.57)
>2 lane, 1 way	10 (7.0)	38 (24.5)	0.18 (0.07-0.50)	0.23 (0.03-1.55)
2 lane, 2 way	64 (44.8)	54 (34.8)	0.80 (0.40-1.59)	1.26 (0.27-5.82)

Abbreviations: AOR, adjusted odds ratio; OR, odds ratio.

[a] Odds ratio from conditional logistic regression matched on sex, hour of the day, and indoor/outdoor status.

[b] Adjusted ORs additionally adjusted for individual factors (age, race, history of arrest, and alcohol and drug use at time of homicide) and location factors (percentage of the population who are black, percentage of the population who are Hispanic, median household income, unemployment, and total nongun crimes).

Table 3

Building Conditions and Adolescent Homicide

Characteristic	Participants, No. (%) Homicide Case	Control	OR (95% CI)[a]	Fully AOR (95% CI)[b]
Property type				
Residential	96 (67.1)	75 (48.4)	1 [Reference]	1 [Reference]
Roughly equal mix	16 (11.2)	22 (14.2)	0.64 (0.32-1.30)	0.48 (0.11-2.00)
Commercial	19 (13.3)	45 (29.0)	0.39 (0.20-0.76)	0.35 (0.10-1.15)
Detached houses				
None visible	119 (83.2)	114 (73.6)	1 [Reference]	1 [Reference]
≥1 visible	12 (8.4)	29 (18.7)	0.35 (0.16-0.78)	1.09 (0.25-4.85)
Attached/row homes				
None visible	15 (10.5)	45 (29.0)	1 [Reference]	1 [Reference]
≥1 visible	116 (81.1)	98 (63.2)	4.53 (2.00-10.28)	4.71 (0.99-22.47)
Housing over storefronts				
None visible	92 (64.3)	105 (67.7)	1 [Reference]	1 [Reference]
≥1 visible	39 (27.3)	38 (24.5)	1.20 (0.70-2.04)	0.40 (0.13-1.20)
Building structural condition[c]			2.22 (1.49-3.33)	1.74 (0.87-3.44)
Broken/boarded-up windows				
None	69 (48.3)	108 (69.7)	1 [Reference]	1 [Reference]
1	14 (9.8)	10 (6.5)	1.56 (0.55-4.43)	1.53 (0.32-7.30)
Multiple	47 (32.9)	19 (12.3)	3.60 (1.74-7.46)	2.24 (0.61-8.14)
Security bars/gratings on houses				
None visible	48 (33.6)	94 (60.7)	1 [Reference]	1 [Reference]
≥1 visible	78 (54.6)	32 (20.7)	6.67(3.00-14.84)	9.23 (2.45-34.80)
Security bars/gratings on businesses				
None visible	36 (25.2)	63 (40.7)	1 [Reference]	1 [Reference]
≥1 visible	42 (29.4)	28 (18.1)	1.94 (0.82-4.58)	Unable to calculate
Pull-down metal fencing on business				

Characteristic	Participants, No. (%) Homicide Case	Control	OR (95% CI)[a]	Fully AOR (95% CI)[b]
None visible	41 (28.7)	67 (43.2)	1 [Reference]	1 [Reference]
≥1 visible	49 (34.3)	26 (16.8)	2.02 (0.97-4.18)	0.04 (0-79.3)
Security fences				
None visible	44 (30.8)	49 (31.6)	1 [Reference]	1 [Reference]
≥1 visible	87 (60.8)	94 (60.7)	1.03 (0.60-1.75)	0.79 (0.31-2.04)
Furniture on street porches and sidewalk				
None visible	73 (51.1)	108 (69.7)	1 [Reference]	1 [Reference]
≥1 item visible	58 (40.6)	35 (22.6)	2.29 (1.28-4.09)	2.01 (0.71-5.66)
Murals				
None visible	111 (77.6)	124 (80)	1 [Reference]	1 [Reference]
Any visible	20 (14.0)	19 (12.3)	0.92 (0.44-1.94)	0.42 (0.11-1.48)
Graffiti				
None visible	76 (53.2)	87 (56.1)	1 [Reference]	1 [Reference]
Any visible	55 (38.5)	51 (32.9)	1.58 (0.85-2.92)	0.95 (0.31-2.89)

Abbreviations: AOR, adjusted odds ratio; OR, odds ratio.

[a] Odds ratio from conditional logistic regression matched on sex, hour of the day, and indoor/outdoor status.

[b] Adjusted ORs additionally adjusted for individual factors (age, race, history of arrest, and alcohol and drug use at time of homicide) and location factors (percentage of the population who are black, percentage of the population who are Hispanic, median household income, unemployment, and total nongun crimes).

[c] Odds ratio related to 1-point increase in mean structural condition scale (1 = very well kept to 4 = poor).

Table 4

Natural Surroundings and Adolescent Homicide

Characteristic	Participants, No. (%) Homicide Case	Control	OR (95% CI)[a]	Fully AOR (95% CI)[b]
Park				
None	122 (85.3)	123 (79.4)	1 [Reference]	1 [Reference]
≥1	7 (4.9)	16 (10.3)	0.45 (0.16-1.27)	0.09 (0.01-0.88)
Playground				
None	115 (80.4)	128 (82.6)	1 [Reference]	1 [Reference]
≥1	15 (10.5)	15 (9.7)	0.99 (0.44-2.22)	1.00 (0.23-4.32)
Neglected vacant lot				
None	111 (77.6)	120 (77.4)	1 [Reference]	1 [Reference]
≥1	20 (14.0)	23 (14.8)	1.12 (0.57-2.20)	0.70 (0.21-2.31)
Maintained vacant lot				
None	111 (77.6)	127 (81.9)	1 [Reference]	1 [Reference]
≥1	20 (14.0)	16 (10.3)	1.31 (0.59-2.90)	0.17 (0.03-0.81)
Planted trees				
None to sparse	34 (23.8)	26 (16.8)	1 [Reference]	1 [Reference]
Moderate to dense	97 (67.8)	117 (75.5)	0.65 (0.35-1.22)	0.49 (0.16-1.50)
Public bushes or plantings				
None	104 (72.7)	94 (60.7)	1 [Reference]	1 [Reference]
≥1	24 (16.8)	37 (23.9)	0.56 (0.30-1.05)	0.76 (0.22-2.71)
Private bushes or plantings				
None	55 (38.5)	54 (34.8)	1 [Reference]	1 [Reference]
≥1	70 (49.0)	72 (46.5)	1.01 (0.59-1.71)	3.44 (1.18-10.01)

Abbreviations: AOR, adjusted odds ratio; OR, odds ratio.

[a] Odds ratio from conditional logistic regression matched on sex, hour of the day, and indoor/outdoor status.

[b] Adjusted ORs additionally adjusted for individual factors (age, race, history of arrest, and alcohol and drug use at time of homicide) and location factors (percentage of the population who are black, percentage of the population who are Hispanic, median household income, unemployment, and total nongun crimes).