Misdemeanor Policing, Physical Disorder, and Gun-related Homicide

A Spatial Analytic Test of "Broken-Windows" Theory

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Background: Homicide contributes substantially to the burden of death in the US and remains a key contributor to the gap in white-black life expectancy. It has been hypothesized that "broken-windows" policing is associated with lower homicide rates and that physical disorder may mediate this association. However, the empiric evidence is limited and conflicting.

Methods: We used pooled, cross-sectional time-series data for 74 New York City (NYC) Police Precincts between 1990 and 1999 to test the relation between neighborhood misdemeanor policing (an indicator of physical order) and homicide in NYC in the 1990s. We applied Bayesian hierarchical models, including a random effect of place, to account for serial correlations in homicide across adjacent neighborhoods.

Results: An increase of 5000 misdemeanor arrests in a precinct with 100,000 people was associated with a reduction of 3.5 homicides (95% credible interval = −5.00 to −1.00). However, increased misdemeanor arrests were associated with lower physical order (posterior median = −0.015 [−0.025 to −0.01]), and physical order was unrelated to homicide.

Conclusions: Our study replicated prior findings suggesting that misdemeanor policing reduces homicide rates, but offered no support for the hypothesis that physical disorder is a mediator of the impact of such policing. Factors responsible for the dramatic decline in US homicides in the last decade remain unclear.

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Violence is an important public health concern.[1–3] Homicide and nonfatal assaults contribute substantially to the burden of death, injury, and disability[4] and remain 2 of the main contributors to the white-black life expectancy gap.[2] Violence increases the cost of health and welfare services, reduces national productivity, decreases property values, and disrupts essential social services. Understanding the determinants of rising and declining trends in violent crime may help inform public policies to reduce such crime.

The thesis of "broken-windows" policing, formulated by Wilson and Kelling,[5] is one of the most controversial and influential explanations for the homicide decline in major US cities in the 1990s. The authors argue that failure to control minor offenses such as prostitution and disorderly conduct destabilizes neighborhoods by creating a sense of public disorder. People may be more likely to turn to crime in neighborhoods where toleration of petty crimes indicates a lack of effective social control. This idea has motivated the adoption of aggressive enforcement of misdemeanor laws in major cities in the United States.[6]

Research on the impact of policing on the homicide decline in New York City (NYC) and elsewhere in the US has yielded mixed results.[6–12] Kelling and Sousa[13] found that the misdemeanor arrest rate predicted change in violent crime across police precincts in NYC in the 1990s. In a reanalysis of the same data, Harcourt and Ludwig[6] found that controlling change in violent crime rates before 1990 and baseline precinct covariates eliminated the association between misdemeanor arrests and crime rates. Alternative explanations for the drop in homicides in the US in the 1990s have been offered, including greater imprisonment, increases in the number of police, change in the drug markets, and economic expansion.[7,11,14]

Two recent studies have moved the question of the effectiveness of misdemeanor policing to the forefront. Messner et al[15] extended the work of Kelling and Sousa and of Harcourt and Ludwig by disaggregating the relative influence of policing and drug activity on gun and nongun-related homicides, while controlling for felony arrests (which may confound the effect of misdemeanor policing on crime) and employing a more refined measure of drug activity. Rosen-

feld et al[12] employed a more reliable measure of policing, controlling for the influence of citizen complaints of disorder on the police response, and spatial lags in policing and homicide/robbery. Both studies found that misdemeanor policing had a small effect on homicide rates.

Although both of these papers made important contributions to the literature, neither reported evidence that a reduction in neighborhood disorder was the mechanism by which changes in misdemeanor policing led to the homicide decline. Messner et al[15] did not take into account physical disorder or spatial effects. Rosenfeld et al[12] considered a different question: they were interested in investigating disorder as a determinant of order-maintenance policing, rather than as a mediator of its effect.

The relation between disorder and crime is also the subject of some debate. Although 2 cross-sectional studies[16,17] showed a positive correlation between disorder and crime, subsequent longitudinal studies have failed to find an association, particularly once levels of concentrated poverty and collective efficacy were controlled.[18–20] It has been argued that disorder and crime have shared origins, but no causal connection to each other.[19] Moreover, recent research has failed to find support for one of the key underlying assumptions of broken-windows theory—that in order for disorder to cause an increase in crime, disorder and crime must be conceptually and empirically distinct.[21]

In this study, we build on previous work on the broken-windows theory. We explore the process through which policing affects homicide, by testing whether misdemeanor policing leads to a decrease in physical signs of disorder (which would be expected if such policing revitalizes neighborhoods) and whether lower levels of disorder, in turn, lead to lower rates of homicide. Figure 1 presents a conceptual diagram of the associations investigated.

METHODS

Data for this study were collected from 5 sources: the Office of the Chief Medical Examiner of New York City, the NYC Police Department, the NYC Human Resources Administration, the NYC Mayor's Management Office, and the United States Census Bureau. The units of analysis were the 74 NYC police precincts, in all 5 NYC boroughs. We considered precincts to be the most appropriate unit of analysis to study the impact of broken-windows policing because law enforcement is organized at the precinct level.[22] Precincts 33 and 34 were treated as one precinct because they were split beginning in 1994, whereas precinct 22 was excluded because no one resides in this precinct.

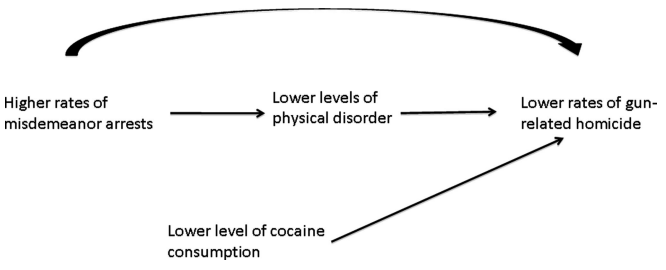

FIGURE 1. Causal diagram of the relationship between misdemeanor policing, physical disorder, cocaine consumption, and gun-related homicide.

Homicide

The homicide measure of interest was gun-related homicide rates. We focus on gun-related homicides because (1) previous research has demonstrated distinct trends for gun versus nongun homicide in NYC and (2) the overall trend for gun-related homicide is more compatible with theoretical claims about an impact of broken-windows policing.[9] All cases of homicides in NYC from 1990 to 1999 were identified through standardized manual review and abstraction of medical files in the Office of the Chief Medical Examiner of New York City. These cases were geocoded to the precinct level by address of injury using ArcGIS software, version 9.0 (ESRI, Redlands, CA). Details regarding these data have been previously published.[15] Only cases with a valid address of injury were included in the analysis.

Homicide rates were calculated per 100,000 population. We estimated the total population in each precinct in each year using a linear interpolation for the years between Census population estimates of 1990 and 2000.

Main Exposures of Interest

Misdemeanor Policing

Data were collected from the NYPD by precinct from 1990 through 1999 to represent broken-windows oriented policing,[6,8,13,15] and expressed as rates per 100,000 population (derived as described earlier).

Neighborhood Physical Order

Percent of community district sidewalks rated as acceptably clean were obtained from the Mayor's Management Office. This office uses a standard scorecard to rate sidewalk cleanliness for a sample of blocks on a monthly basis, and the monthly ratings are averaged for each year. In those boroughs where a community district encompasses more than one police precinct, we assigned the value of that district to all police precincts included within it. eAppendix 1 (http://links.lww.com/A985) describes sensitivity analyses used to validate this measure as an indicator of physical order.[23,24]

Potential Confounders

The control variables included a wide range of sociodemographic characteristics of precincts that have been linked with homicide rates in past macro-level research.[25] With the exception of the measure of public assistance, data for these variables were available only for decennial years, and thus we measured them as time invariant, fixed at the 1990 Census year, using data from the US Census Summary

File 3. Infoshare online (www.infoshare.org) was our source for Census data at the tract level, which were aggregated to the precinct level. The measures included: percent male, percent under age 35, percent black, percent Hispanic, percent foreign-born, percent unemployed, and concentrated poverty. This last variable was a composite score created with principal components analysis by summing the percent of persons living below 200% poverty, the percent with less than a high school education, the percent of female-headed households, and the percent receiving public assistance—each weighted by its factor loading on the first principal component, which accounted for 90% of the variance. The components of the composite score had been standardized before conducting the principal components analysis to prevent those variables with large variance from dominating the solution. Higher scores of the composite score indicated greater levels of concentrated poverty. We also standardized all time-invariant control variables to have a mean of 0 and a standard deviation of 1, to improve convergence.

In addition to the indicators of sociodemographic characteristics of precincts, controls were included for 6 other variables available on an annual basis. Public assistance (obtained from the Human Resources Administration), was selected as a measure of time-varying neighborhood disadvantage; it has been previously shown to correlate highly with other indicators of disadvantage.[26–29] Felony arrest rates per 100,000 people were collected from the NYC Police Department by police precinct from 1990 through 1999; these rates were included to control for police activity not related to broken-windows policing. The indicator of manpower was the number of police officers assigned to each police precinct from 1990 through 1999 by the Police Department. The level of cocaine use in each precinct was measured as the percent of accident decedents whose toxicology results were positive for cocaine that occurred in each precinct in each year 1990–1999, recorded from the Medical Examiner's data. The proxy for firearm availability was the annual percent of suicide deaths where guns were used, per precinct, recorded from Medical Examiner's data. This measure is a valid proxy for firearm availability in that it correlates highly with survey-based measures of firearms.[30] Finally, we included a measure of the incarceration rate per 100,000 population, operationalized as the number of prison admissions by precinct-of-arrest from 1990 through 1999, and obtained from the New York State Division of Criminal Justice Services.

Statistical Analyses

All analyses were based on "change" Bayesian hierarchical models, commonly used in disease mapping.[31,32] Models were of the following form:

$$\Delta Y_{it} = \alpha_i + \beta_1 \Delta X_{arrests_{it}} + \beta_2 \Delta X_{publicassist_{it}} + \beta_3 \Delta X_{order_{it}} + \mathrm{XB}_i + \lambda_i$$

$$\lambda \sim \mathrm{CARNormal}\,(\mathrm{W}, \tau_\lambda)$$

$$\tau_\lambda \sim \mathrm{Gamma}\,(0.5, 0.0005)$$

where ΔY_{it} was the change in the homicide rate between times t and $t + 1$ for the precinct i for time period t, $\Delta X_{arrests_{it}}$ was the change in the misdemeanor arrest rate between times t and $t + 1$, $\Delta X_{publicassist_{it}}$ was the change in proportion of residents receiving public assistance, $\Delta X_{order_{it}}$ was the change in the rate of sidewalk order, X was a set of baseline covariates, and λ_i was the random spatially-structured effect.[33] We used spatial error models to account for the spatial dependence of risk for homicide in nearby areas. The spatial random effect was modeled with a prior that has a conditionally autoregressive distribution (CAR), with weights for first-order adjacent neighbors set at 1 ("neighbors" defined as precincts sharing a border).[34] All models were estimated with Winbugs with 2 parallel Markov chain Monte Carlo chains. We computed posterior medians and 95% credible intervals. Details about these spatial models are provided in eAppendix 2 (http://links.lww.com/A985).

First, we examined the predictors of neighborhood physical order to assess the initial link in the process relating misdemeanor policing to homicide. Models were constructed using the misdemeanor arrest rate alone as a predictor, then adding public assistance and then introducing a full set of baseline control variables. We then examined the predictors of neighborhood homicide rates. Models began with the misdemeanor arrest rate alone as a predictor. We then added neighborhood physical order, and then public assistance. Each of these 3 models was repeated, including the full set of baseline control variables. Finally, we constructed a model with misdemeanor arrests, physical order, public assistance, and baseline covariates, plus a set of measures of alternative explanations for the homicide drop (an indicator of cocaine use, a measure of firearm availability, and a measure of the incarceration rate). These models estimated the contemporaneous association between change in the predictors and change in homicide. We also conducted a sensitivity analysis, whereby 1-year lagged change in the predictor variables (except for disorder, as it was posed as a mediator), was associated with change in homicide.

RESULTS

Of 14,186 homicides that occurred in New York City between 1990 and 1999, 2027 (14%) were missing precinct-of-injury information, and thus were excluded from our analyses. This left a total of 12,159 homicides classified by precinct of injury. Women and those of any race other than black were more likely to be missing precinct-of-injury information. Of these, 8820 (73%) were firearm-related and were thus used in the analysis. Homicide counts geocoded by precinct based on data from the Medical Examiner correlated between 0.85 and 0.95 (depending on the year) with homicide counts from the NY Police Department.

Table 1 presents the demographic characteristics of all precincts, and precincts stratified by gun-related homicide

TABLE 1. Descriptive Statistics for NYC Police Precincts, by Level of Gun-related Homicide, 1990–1999

	Level of Gun-related Homicides[a]		
	Total (n = 74) Mean (SD)	Low (n = 36) Mean (SD)	High (n = 38) Mean (SD)
Total gun-related homicide rate (per 100,000 population)[b]	13.9 (16.2)	4.6 (4.6)	22.6 (18.3)
Exposures of interest			
Misdemeanor arrest rate (per 100,000 population)[c]	4748 (5075)	3088 (4540)	6312 (5061)
Percent acceptably clean sidewalks[b]	80 (13)	87 (9)	73 (13)
Percent receiving public assistance[c]	13 (10)	7 (4)	19 (10)
Control variables			
Percent male[d]	47 (2.3)	48 (1.8)	46 (2.6)
Percent age <35 years[d]	52 (7.6)	48 (5.2)	56 (7.5)
Percent black[d]	27 (27)	12 (16)	42 (29)
Percent Hispanic[d]	24 (18)	17 (11)	30 (21)
Percent foreign-born[d]	26 (12)	28 (12)	24 (13)
Percent unemployed[d]	4.5 (1.2)	3.8 (0.8)	5.2 (1.0)
Concentrated poverty[d,e]	91 (42)	65 (23)	116 (41)
Felony arrest rate (per 100,000 population)[c]	2449 (2168)	1321 (1514)	3510 (2156)
Size of police force[c]	220 (61)	199 (52)	239 (62)
Proportion of accident decedents positive for cocaine toxicology[c]	8.3 (10.7)	5.5 (7.3)	10.9 (12.5)
Proportion of suicide deaths caused by firearms[c]	19 (21)	18 (20)	20 (22)
Incarceration rate (per 100,000 population)[c]	305 (414)	136 (146)	464 (511)

[a]Police precincts with total gun-related homicide rates at or below the median were classified as having low levels of homicide, whereas police precincts with total gun-related homicide rates above the median were classified as having high levels of homicide.
[b]Measures available each year, 1991–1999.
[c]Measures available each year, 1990–1998.
[d]Measures available at one point in time (1990).
[e]Concentrated poverty includes the following socioeconomic characteristics aggregated to the police precinct level: percent less than high school education, percent less than 200% poverty, percent female-headed households, and percent receiving public assistance; higher scores indicate higher levels of concentrated poverty.

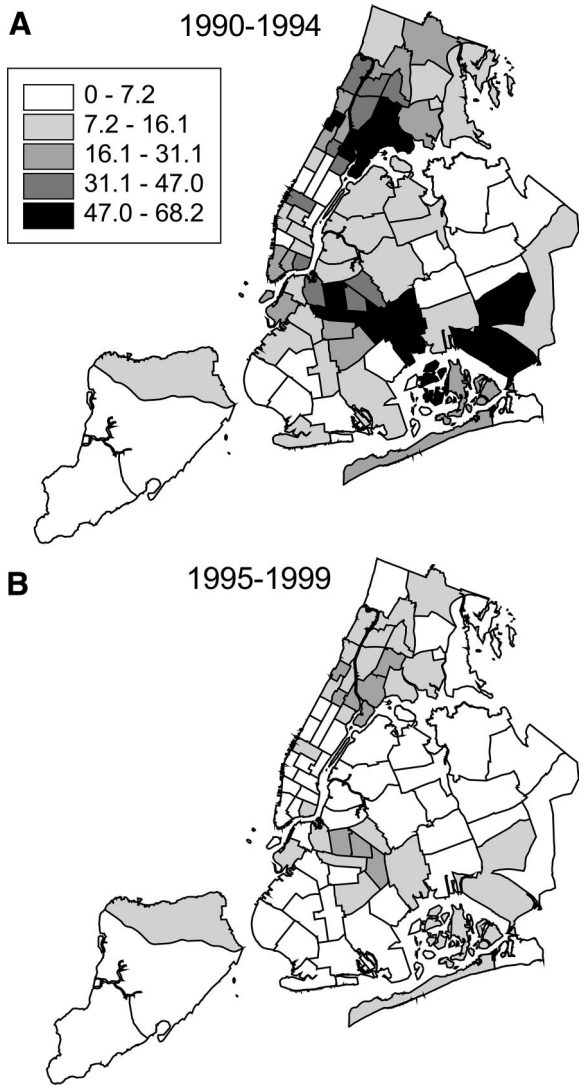

FIGURE 2. Average gun-related homicide rate per 100,000 population by police precinct, New York City; **A**, 1990–1994 and **B**, 1995–1999.

rates (below or above the median). Precincts with low homicide rates had lower levels of misdemeanor arrests (3087 vs. 6311 arrests per 100,000 population) and a higher concentration of clean sidewalks (87% vs. 73%) than precincts with high homicide rates. The lower risk precincts also had lower rates of public assistance receipt (7% vs. 19% of the population), lower concentrations of blacks and Hispanics, and higher concentrations of police force in the precinct.

Figure 2 presents the spatial distribution of homicide in New York City in the 1990s, averaged across 5-year spans. There were systematic differences across precincts, and these spatial patterns changed over time. This was confirmed by an analysis of univariate local indicators of spatial association (LISA statistics), which showed neighborhood clusters of homicide in the first and second half of the decade. Global Moran's I statistics for each 5-year span were higher than the −0.0137 expected for 74 precincts (0.41 in 1990–1994 and 0.38 in 1995–1999).[32]

Predictors of annual change in levels of physical order are given in Table 2. For ease of interpretation, the metric of changes in misdemeanor arrests is expressed in units of 5000 arrests for all models. Model 1 presents the bivariate association between change in the rate of misdemeanor arrests and change in the proportion of clean sidewalks in the precinct. This model showed a weak negative association between policing and the proportion of clean sidewalks: an increase of 5000 misdemeanor arrests in a neighborhood of 100,000 people was associated with a 0.015-unit decrease (95% cred-

TABLE 2. Bayesian Hierarchical Models, Including a Space Random Effect, Predicting Change in Neighborhood Physical Order (Percent of Acceptably Clean Sidewalks), NYC Police Precincts, 1990–1999[a]

	Model 1 Posterior Median (95% Credible Interval)	Model 2 Posterior Median (95% Credible Interval)	Model 3 Posterior Median (95% Credible Interval)
Exposures of interest			
Change in misdemeanor arrest rate (per 5000 arrests)[b]	−0.015 (−0.025 to −0.01)	−0.015 (0.000 to −0.025)	−0.015 (−0.025 to −0.01)
Change in percent receiving public assistance[c]		−0.05 (−0.17 to 0.06)	−0.02 (−0.13 to 0.10)
Control variables			
Percent male[d]			−0.0006 (−0.004 to 0.005)
Percent age <35 years[d]			0.000 (−0.008 to 0.008)
Percent black[d]			0.001 (−0.006 to 0.009)
Percent Hispanic[d]			0.000 (−0.008 to 0.009)
Percent foreign-born[d]			−0.001 (−0.005 to 0.003)
Percent unemployed[d]			0.000 (−0.008 to 0.009)
Concentrated poverty[d,e]			0.009 (−0.0004 to 0.02)
Change in felony arrest rate[b]			0.000 (0.000 to 0.000)
Change in manpower[f]			0.000 (0.000 to 0.000)
Standard deviation			
Total standard deviation (square root of $1/\tau$)	0.04 (0.04 to 0.04)	0.04 (0.04 to 0.04)	0.04 (0.04 to 0.04)
Spatial standard deviation (square root of $1/\tau_\lambda$)	0.01 (0.01 to 0.02)	0.01 (0.01 to 0.02)	0.01 (0.01 to 0.01)
Intercept	0.02 (0.02 to 0.02)	0.01 (0.01 to 0.02)	0.02 (0.01 to 0.02)

[a]Models based on 50,000–100,000 iterations (10,000 samples).
[b]Misdemeanor and felony arrest rates were expressed per 100,000 population before calculating annual change.
[c]Percent receiving public assistance in 1990 at the police precinct level was approximated from the community district level; 1993 public assistance data are a linear interpolation between 1992 and 1994 data.
[d]1990 census variables were standardized to have mean of 0 and standard deviation of 1.
[e]As defined in Table 1 footnote.
[f]Annual change in size of police force in precinct.

TABLE 3. Bayesian Hierarchical Models, Including Space Random Effect, Predicting Change in Total Gun-related Homicide Rate, NYC Police Precincts, 1990–1999[a]

	Model 1 Posterior Median (95% Credible Interval)	Model 2 Posterior Median (95% Credible Interval)	Model 3 Posterior Median (95% Credible Interval)
Exposures of interest			
Change in misdemeanor arrest rate (per 5000 arrests)[b]	−4.5 (−5.0 to −2.0)	−4.5 (−5.0 to −2.0)	−4.5 (−5.0 to −1.5)
Change in percent acceptably clean sidewalks[c]		2.2 (−13 to 18)	0.76 (−15 to 16)
Change in percent receiving public assistance[d]			−35 (−58 to −11.9)
Standard deviation			
Total standard deviation (square root of $1/\tau$)	10 (7 to 10)	10 (7 to 10)	10 (7 to 10)
Spatial standard deviation (square root of $1/\tau_\lambda$)	0.04 (0.01 to 0.44)	0.04 (0.01 to 0.50)	0.04 (0.01 to 0.59)
Intercept	−2.01 (−2.62 to −1.39)	−2.04 (−2.7 to −1.37)	−2.39 (−3.11 to −1.67)

[a]Models based on iterations 50,000–100,000 (10,000 samples).
[b]Misdemeanor and felony arrest rates were expressed per 100,000 population before calculating annual change.
[c]Percent acceptably clean sidewalks at the police precinct level was approximated from the community district level.
[d]Percent receiving public assistance in 1990 at the police precinct level was approximated from the community district level; 1993 public assistance data are a linear interpolation between 1992 and 1994 data.

ible interval = −0.025 to −0.01) in the proportion of clean sidewalks in the precinct. Controlling for the percent of people on public assistance in the precinct, the weak association between arrests and sidewalk cleanliness was unchanged (Model 2). Similarly, introducing a set of baseline covariates did not change the magnitude or direction of the main associations of interest (Model 3).

Table 3 presents the predictors of homicide changes in the 1990s, incorporating a smoothing parameter for adjacent neighborhoods. Change in misdemeanor arrests was negatively but weakly associated with change in homicides; in a precinct with 100,000 people, an increase of 5000 arrests was associated with a decrease of 4.5 homicides (95% credible interval = −5.0 to −2.0) (Model 1). Model 2 incorporated change in sidewalk cleanliness as an additional predictor; this was not associated with the rate of homicide. Finally, Model 3 also included annual change in public assistance receipt, which was a negative predictor of homicide (posterior median: −35 [95% credible interval = −58 to −12]). Controlling for public assistance did not change the association between policing and homicide.

Table 4 presents the same models as Table 3, controlling for a set of baseline structural characteristics and then for a set of alternative potential predictors of the homicide drop. The association between annual change in misdemeanor arrests and change in homicide remained negative (Model 1) and the association between sidewalk cleanliness and homicide remained null (Model 2), regardless of the covariates included in the models. In contrast with the negative effect of misdemeanor policing, felony arrest rates were not an impor-

TABLE 4. Bayesian Hierarchical Models, Including Space Random Effect, Predicting Change in Total Gun-related Homicide Rate, Including Control Variables, NYC Police Precincts, 1990–1999[a]

	Model 1 Posterior Median (95% Credible Interval)	Model 2 Posterior Median (95% Credible Interval)	Model 3 Posterior Median (95% Credible Interval)	Model 4 Posterior Median (95% Credible Interval)
Exposures of interest				
Change in misdemeanor arrest rate (per 5000 arrests)[b]	−3.5 (−5.0 to −1.0)	−3.5 (−5.0 to −1.0)	−3.0 (−5.0 to −0.3)	−3.5 (−5.0 to −1.0)
Change in percent acceptably clean sidewalks[c]		10 (−6 to 26)	9 (−6 to 25)	9 (−6 to 25)
Change in percent receiving public assistance[d]			−47.05 (−70.36 to −23.51)	−45.35 (−68.36 to −21.25)
Control variables				
Percent male[e]	−0.26 (−1.01 to 0.50)	−0.27 (−1.02 to 0.47)	−0.35 (−1.08 to 0.39)	−0.35 (−1.08 to 0.41)
Percent age <35 years[e]	−0.37 (−1.88 to 1.11)	−0.42 (−1.90 to 1.06)	−0.31 (−1.82 to 1.17)	−0.32 (−1.79 to 1.16)
Percent black[e]	−0.53 (−1.92 to 0.87)	−0.46 (−1.88 to 0.89)	−0.52 (−1.90 to 0.87)	−0.55 (−1.91 to 0.83)
Percent Hispanic[e]	−0.08 (−1.58 to 1.39)	−0.005 (−1.47 to 1.44)	−0.03 (−1.48 to 1.46)	−0.05 (−1.49 to 1.37)
Percent foreign-born[e]	0.22 (−0.48 to 0.93)	0.22 (−0.49 to 0.93)	0.31 (−0.42 to 1.02)	0.29 (−0.41 to 0.99)
Percent unemployed[e]	−0.13 (−1.70 to 1.44)	−0.19 (−1.76 to 1.37)	−0.16 (−1.72 to 1.391)	−0.06 (−1.61 to 1.45)
Concentrated poverty[e,f]	−0.64 (−2.20 to 0.89)	−0.71 (−2.29 to 0.87)	−1.06 (−2.61 to 0.47)	−1.13 (−2.65 to 0.41)
Change in felony arrest rate[b]	−0.001 (−0.002 to 0.000)	−0.001 (−0.002 to 0.000)	−0.001 (−0.002 to 0.000)	−0.001 (−0.003 to 0.000)
Change in manpower[g]	0.01 (−0.03 to 0.05)	0.01 (−0.02 to 0.05)	−0.002 (−0.04 to 0.04)	−0.003 (−0.04 to 0.04)
Change in cocaine use[h]				0.07 (0.02 to 0.12)
Change in firearm availability[i]				0.01 (−0.01 to 0.04)
Change in incarceration rate[b]				0.002 (−0.01 to 0.01)
Standard deviation				
Total standard deviation (square root of $1/\tau$)	10 (7.07 to 10)	10 (7.07 to 10)	7.07 (7.07 to 10)	7.07 (7.07 to 10)
Spatial standard deviation (square root of $1/\tau_\lambda$)	0.04 (0.01 to 0.39)	0.04 (0.01 to 0.42)	0.04 (0.01 to 0.40)	0.04 (0.01 to 0.39)
Intercept	−2.21 (−2.87 to −1.56)	−2.37 (−3.10 to −1.67)	−2.78 (−3.51 to −2.07)	−2.69 (−3.41 to −1.96)

[a] Models based on 50,000–100,000 iterations (10,000 samples).
[b]Misdemeanor arrest, felony arrest, and incarceration rates were expressed per 100,000 population before calculating annual change.
[c]Percent acceptably clean sidewalks at the police precinct level was approximated from the community district level.
[d]Percent receiving public assistance in 1990 at the police precinct level was approximated from the community district level; 1993 public assistance data are a linear interpolation between 1992 and 1994 data.
[e]1990 Census variables were standardized to have mean of 0 and standard deviation of 1.
[f]Concentrated poverty includes the following socioeconomic variables aggregated to the police precinct level: percent less than high school education, percent less than 200% poverty, percent female-headed households, and percent receiving public assistance; higher scores indicate higher levels of concentrated poverty.
[g]Annual change in size of police force in precinct.
[h]Annual change in percent accident decedents with positive cocaine toxicology.
[i]Annual change in percent suicides where guns were used.

tant predictor of gun-related homicides. The magnitude of the association between change in receipt of public assistance and change in homicide became stronger (Model 3 in Table 4 vs. Model 3 in Table 3). Incorporating alternative predictors of the homicide decline (Model 4) did not have an impact on the association between the predictors of interest and homicide. Increased levels of misdemeanor arrests remained associated with decreases in homicide (−3.5 per 5000 misdemeanor arrests [−5.0 to −1.0]). However, change in the cocaine drug markets, measured as the percent of accident decedents whose toxicology results were positive for cocaine, was a positive predictor of homicide (posterior median: 0.07 [95% credible interval = 0.02 to 0.12]). Regardless of the number of covariates introduced, the models consistently indicated minimal spatial autocorrelation (Model 4: posterior median = 0.04 [95% credible interval = 0.01 to 0.39]).

A sensitivity analysis of Model 4 was conducted, with 1-year lags imposed for all time-varying covariates except for disorder (model not shown). Lagged change in misdemeanor arrests and in cocaine consumption were not associated with change in the homicide rate, suggesting no late-emerging effects from changes in these variables.

DISCUSSION

This study re-examines one of the leading explanations for the decline in homicide in New York City in the 1990s, the namely broken-windows hypothesis. Our analyses are based on pooled, cross-sectional time-series data for 74 NYC police precincts from 1990 through 1999. The results of the marginal Bayesian regression models reaffirm the key findings from recent papers on the homicide drop in NYC[12,15,35]: an increase in misdemeanor arrests over the 1990s made a small contribution to the reduction in homicide rates, while change in cocaine consumption also had an impact. The study provides further evidence that changes in policing and drug market activity may have contributed (along with other factors) to the dramatic homicide decline in NYC in the 1990s.

Policing increased in certain precincts between 1994 and 1996, as part of a concerted effort to reduce "public disorder" that is thought to encourage crime.[36] This effort went beyond the usual response to prior crime: when William J. Bratton became NYC Police Commissioner, he advocated "strict enforcement of laws against quality-of-life offenses such as subway turnstile jumping, aggressive panhandling, drinking and being drunk in public, and soliciting prostitutes."[37] The increase in misdemeanor policing coincided with this new policy: more than twice as many nonfelony arrests were made in 1998 as in 1989, while the number of felony arrests declined in the same period.[15] The increase in misdemeanor policing was thus part of a deliberate policy intervention.

A key element of the broken-windows hypothesis—that misdemeanor policing reduces homicides through a decrease in physical disorder—is not supported in our analyses. An increase in misdemeanor policing was actually associated with an increase in physical disorder. However, this physical disorder had no association with homicide. The lack of an association between disorder and homicide should be interpreted with caution, however, as we used a proxy measure of disorder, which is subject to estimation error.

The anomalous negative association between misdemeanor policing and physical order observed here suggests a possible reverse causal relationship. Neighborhoods with lower levels of physical order may generate demand for more misdemeanor policing. Consistent with this interpretation, Rosenfeld et al[12] found that disorder, measured as citizen complaints of misdemeanor and ordinance violations, predicted higher levels of policing. However, if this process is in fact operating, it is inconsistent with theoretical arguments predicated on the premise that physical disorder goes hand-in-hand with the abandonment of neighborhoods. Citizen complaints to the police would seem to be more likely when residents are mobilized on behalf of the neighborhood. Note also that, whatever the association between physical disorder and misdemeanor policing, the null relationship between physical disorder and homicide gives no support to the hypothesized mediating effect.

Also unexpected, public assistance was associated with lower levels of homicide. The public assistance measure, which is independent of initial levels of deprivation captured in the composite index of concentrated poverty, may reflect benefits of extending the social safety net to additional segments of the population. Prior research at the subnational and national level has suggested that more generous and expansive social welfare policies reduce stressors in the environment and strengthen institutional controls, thereby reducing levels of lethal violence.[38–40]

There are some questions about the robustness of these associations in our data. The association between misdemeanor policing and homicide, and between cocaine consumption and homicide, proved to be sensitive to the specification of the temporal process. The results reported earlier assume simultaneous effects of changes in policing and cocaine consumption on changes in homicide. A sensitivity analysis was also conducted, wherein changes in policing and cocaine consumption were measured with 1-year lags. The associations disappeared in the lagged models.

Nonexperimental designs suffer from potential endogeneity and unobserved confounding. We addressed concerns about the rate of misdemeanor arrests reflecting a response to underlying levels of violence by including controls for levels of police manpower and felony arrests. However, we cannot conclusively differentiate the impact of misdemeanor policing from other policing practices, or from correlated measures of changes in social conditions. For example, prior neighborhood research has identified "collective efficacy" as an important predictor of levels of crime that presumably operates primarily through

enhanced informal social control. It is plausible to speculate that collective efficacy might also affect formal control–residents of mobilized neighborhoods might be better able to secure more vigorous policing. If such processes operate, they may generate a spurious association between changes in misdemeanor arrests and changes in homicide. It is also possible, however, that increased misdemeanor policing might promote greater collective efficacy, thereby yielding an indirect effect of policing on homicide in addition to any direct effect. Future studies need to explore the contribution of this particular neighborhood characteristic and other potential confounders on the association between policing and homicide.

The analysis is also constrained by the available data. For Census-based measures, we were restricted to estimating effects of precinct characteristics in 1990 with annual rates of change in homicide over the next decade. Elapsed time between 1990 and later years weakens the power of the control variables to deal with unobserved heterogeneity. We are unable to estimate, for example, how changing age and sex structure of the population may have affected the relationship between our covariates of interest and gun-related homicides. We are also restricted to using public assistance as a measure of economic disadvantage, which may have limited our ability to control for the impact that other dimensions of disadvantage, separate from welfare receipt, had on homicide.

Violent crime is one of the leading causes of death and disability. Understanding the types of policy and area-level changes that can effectively lead to a decline in violence remains a public health priority. Our study replicates the finding that misdemeanor arrests have a small protective impact on homicide, but we find that physical order is not a plausible mechanism through which policing operates. Drug activity and public assistance were associated with changes in homicide, indicate that policing is not the sole factor responsible for the homicide decline in NYC. These findings underscore the need for further inquiry into the full range of factors, including not only law enforcement practices but structural and cultural conditions that increase or decrease levels of criminal violence in urban neighborhoods.

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REFERENCES

1. Freudenberg N, Fahs M, Galea S, Greenberg A. The impact of New York City's 1975 fiscal crisis on the tuberculosis, HIV, and homicide syndemic. *Am J Public Health*. 2006;96:424–434.
2. Harper S, Lynch J, Burris S, Smith GD. Trends in the black-white life expectancy gap in the United States, 1983–2003. *JAMA*. 2007;297:1224–1232.
3. Krug E. *World Report on Violence and Health*. Geneva: World Health Organization; 2002.
4. Reza Aea. Epidemiology of violent deaths in the world. *Inj Prev*. 2001;7:104–111.
5. Wilson JQ, Kelling GL. Broken windows: The police and neighborhood safety. *Atl Mon*. 1982;127:29–38.
6. Harcourt BE, Ludwig J. Broken windows: New evidence from New York City and a five-city social experiment. *Univ Chic Law Rev*. 2006;73:271–320.
7. Blumstein A, Rivara FP, Rosenfeld R. The rise and decline of homicide-and why. *Ann Rev Public Health*. 2000;21:505–541.
8. Corman H, Mocan N. Carrots, sticks, and broken windows. *J Law Econ*. 2005;48:235–266.
9. Fagan J, Davies G. Policing guns: Order maintenance and crime control in New York. In: Harcourt BE, ed. *Guns, Crime, and Punishment in America*. New York: New York University Press; 2003.
10. Joanes A. Does the New York city police department deserve credit for the decline in New York City's homicide rates? A cross-city comparison of policing strategies and homicide rates. *Columbia J Law Soc Probl*. 2000;33:265–311.
11. Levitt SD. Understanding why crime fell in the 1990s: Four factors that explain the decline and six that do not. *J Econ Perspect*. 2004;18:163–190.
12. Rosenfeld R, Fornango R, Rengifo AF. The impact of order-maintenance policing on New York City homicide and robbery rates: 1988–2001. *Criminology*. 2007;45:355–384.
13. Kelling GL, Sousa WH. *Do Police Matter? An Analysis of the Impact of New York City's Police Reforms*. New York: Manhattan Institute; 2001. Civic Report No. 22.
14. Blumstein A. Youth violence, guns, and the illicit-drug industry. *J Crim Law Criminol*. 1995;86:10–36.
15. Messner SF, Galea S, Tardiff KJ, et al. Policing, drugs, and the homicide decline in New York City in the 1990s. *Criminology*. 2007;45:385–413.
16. Skogan WG. *Disorder and Decline: Crime and the Spiral of Decay in American Neighborhoods*. New York: The Free Press; 1990.
17. Wilcox P, Quisenberry N, Cabrera DT, Jones S. Busy places and broken windows? Toward defining the role of physical structure and process in community crime models. *Sociol Q*. 2004;45:185–207.
18. Markowitz FE, Bellair PE, Liska AE, Liu JH. Extending social disorganization theory: Modeling the relationships between cohesion, disorder, and fear. *Criminology*. 2001;39:293–320.
19. Sampson RJ, Raudenbush SW. Seeing disorder: Neighborhood stigma and the social construction of "Broken windows." *Soc Psychol Q*. 2004;67:319–342.
20. Taylor RB. *Breaking Away From Broken Windows: Baltimore Neighborhoods and the Nationwide Fight Against Crime, Grime, Fear, and Decline*. New York: Westview; 2001.
21. Gau JM, Pratt TC. Broken Windows or Window Dressing? Citizens' (In)ability to Tell the Difference Between Disorder and Crime. *Criminol Public Policy*. 2008;7:163–194.
22. Fagan J, West V, Holland J. Reciprocal effects of crime and incarceration in New York City neighborhoods. *Fordham Urban Law J*. 2003;30:1551–1602.
23. Brady T. *Measuring What Matters: Part One: Measures of Crime, Fear and Disorder*. Washington, DC: A joint publication of the National Institute of Justice and the Office of Community Oriented Policing Services; 1996.
24. Sampson RJ, Raudenbush SW. Systematic social observation of public spaces: A new look at disorder in urban neighborhoods. *Am J Sociol*. 1999;105:603–651.
25. Land KC, McCall PL, Cohen LE. Structural covariates of homicide rates - are there any invariances across time and social space. *Am J Sociol*. 1990;95:922–963.
26. Robert SA. Socioeconomic position and health: The independent contribution of community socioeconomic context. *Ann Rev Sociol*. 1999;25:489–516.
27. Sampson RJ, Raudenbush SW, Earls F. Neighborhoods and violent crime: a multilevel study of collective efficacy. *Science*. 1997;277:918–924.
28. Sun I, Triplett R, Gainey R. Neighborhood characteristics and crime: A test of Sampson and Groves' model of social disorganization. *West Criminol Rev*. 2004;5:1–16.

29. Wilson WJ. *The Truly Disadvantaged: The Inner City, the Underclass, and Public Policy*. Chicago: London: University of Chicago Press; 1987.
30. Azrael D, Cook P, Miller M. State and local prevalence of firearms ownership measurement, structure and trends. *J Quant Criminol*. 2004;20:43–62.
31. Clayton D, Kaldor J. Empirical Bayes estimates of age-standardized relative risks for use in disease mapping. *Biometrics*. 1987;43:671–681.
32. Waller L, Gotway C. *Applied Spatial Statistics for Public Health Data*. New York: John Wiley and Sons; 2004.
33. Xia H, Carlin B. Spatio-temporal models with errors in covariates: mapping Ohio lung care mortality. *Stat Med*. 1998;17:2025–2043.
34. Richardson S, Abellan J, Best N. Bayesian spatio-temporal analysis of joint patterns of male and female lung cancer risks in Yorkshire (UK). *Stat Methods Med Res*. 2006;15:385–407.
35. Ousey G, Lee M. Homicide trends and illicit drug markets: exploring differences across time. *Justice Q*. 2007;24:48–79.
36. Kelling GL, Bratton WJ. Declining crime rates: Insiders' views of the New York City story. *J Crim Law Criminol*. 1998;88:1217–1231.
37. Conklin JE. *Why Crime Rates Fell*. Boston, MA: Allyn and Bacon; 2003.
38. Hannon L, Defronzo J. The truly disadvantaged, public assistance, and crime. *Soc Probl*. 1998;45:383–392.
39. Messner SF, Rosenfeld R. Political restraint of the market and levels of criminal homicide: A Cross-National Application of Institutional-Anomie Theory. *Soc Forces*. 1997;75:1393–1416.
40. Savolainen J. Inequality, welfare state, and homicide: further support for the institutional anomie theory. *Criminology*. 2000;38:1021–1042.