

Officer Risk Factors Associated with Police Shootings: A Matched Case–Control Study

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ABSTRACT

Particularly with the resurgence of concern over police use of deadly force, there is a pressing need to understand the risk factors that lead to police shootings. This study uses a matched-case–control design to remove confounders of shooting incidents and identify features of officers that increased their risk of shooting. By matching shooting officers to nonshooting officers at the same scene, the analysis isolates the role of the officers' features from the features of the incident's environment. The study uses data from the New York City Police Department on 291 officers involved in 106 officer-involved shootings adjudicated between 2004 and 2006. Black officers were 3.3 times and officers rapidly accumulating negative marks in their files were 3.1 times more likely to shoot than other officers. Officers who started their police career later in life were less likely to shoot. The results indicate that officer features related to discharging a firearm are identifiable.

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1. Introduction



Police use of force is currently the subject of vigorous debate. There is considerable uncertainty concerning the number of deaths from police use of lethal force. The National Violent Death Reporting System suggests a rate of 1.6 deaths per million people per year based on 2005–2011 data from 16 states (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control 2005), while the Bureau of Justice Statistics reported 2,931 homicides by law enforcement between 2003 and 2009 (Burch 2011) for an annual rate of 1.4 per million. However, Loftin et al. (2003) noted that law enforcement records and vital statistics can both miss justifiable homicides, though law enforcement report 30% more justifiable homicides than vital statistics. They find 8658 deaths between 1976 and 1998 for an annual rate of 1.6 deaths per million. Aside from the deaths resulting directly from police shootings, police shootings can degrade trust in government, with nearly three-quarters of the major urban riots in the United States over the past century sparked by grievances over high-profile police use-of-force incidents, causing further damage, injury, and deaths.

Decades ago, when researchers were examining questionable shootings (Knoohuizen, Fahey, and Palmer 1972; Kobler 1975), they examined the questions of victim race (Robin 1963; Takagi 1974; Kobler 1975; Inn, Wheeler, and Sparling 1977; Meyer 1980), the victims' involvement in violent crime (Robin 1963; Copeland 1986; Fyfe 1980; Kania and Mackey 1977; Matulia 1985; Sherman 1986), community characteristics (Sherman and Langworthy 1979), and situational factors that lead to police shootings (White 2002). While public and prosecutorial attention has turned to the officers involved, existing research has not

adequately addressed the question of why some officers are more likely than others to shoot. This study focuses on this question.

The sparse research on officer risk factors has suggested at times that age and experience matter (Blumberg 1989) and at other times that age and experience do not matter (Fyfe 1978). However, all of the studies trying to explain risk factors are at high risk of unexplained confounding. The officer features associated with shooting risk instead could be the officer features that result in an officer being assigned to a particular precinct, in a particular role, and putting that officer at increased risk of being in the kinds of situations that result in officer-involved shootings (Ho 1994). While these studies have found interesting associations, we are left wondering whether or not those associations are simply a result of how police officers received their assignments. To better understand and mitigate the risk of police shootings we need to study how attributes of officers involved in the incidents impact the likelihood of lethal force and need to do so in a manner that eliminates confounding due to assignment, place, and context of shootings. Such analyses can improve our understanding of the patterns of police shootings and inform how to properly minimize incidents of unnecessary uses of deadly force (Sherman 1980).

Suppose we were interested in a particular officer feature, being a rookie, for example, and its association with the risk of the officer being involved in a shooting. The scientific gold standard would be to somehow randomize rookies and more senior officers to be exposed to different high shooting risk environments and to compare their discharge rates. Such randomization is not plausible. Furthermore, it could eliminate one of the root causes of some shootings, officers getting themselves into situations where they had no other options except to shoot. An

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alternative might be an observational study that compares shooting rates for all rookies to shooting rates for all other officers. However, any differences we might observe would be highly confounded with assignment to positions that have a large impact on increasing risk (e.g., serving high risk warrants) or decreasing risk (e.g., desk jobs and supervisory positions). In fact, all of the shootings adjudicated during the study period occurred during NYPD's Operation Impact, an initiative in which all freshly minted NYPD officers would be deployed after academy graduation to "impact zones," places in New York City with particularly heavy crime burden (Smith and Purtell 2007). If the observed shooting rate for rookies is larger than the rate for other officers, then we do not want to mistakenly conclude that it is due to lack of experience if the cause is that they are assigned straight out of the academy to crime hotspots. These issues were raised in numerous papers by James Fyfe in his seminal work on the topic.

This study aims to learn which officer features influence risk of shooting and, in doing so, identify officer features that improve our understanding of police shootings and provide policy levers. This study uses a matched case-control design, matching shooters to nonshooters on the scene of a shooting incident, to measure the association between officers' risk factors and the shooting risk. This study derives from a more comprehensive review of New York City Police Department (NYPD) firearm policy, training, and discharge review (Rostker et al. 2008).

2. New York City Officer-Involved Shooting Data

This study uses incidence density sampling to form a dataset of officer-involved shootings and the officers on those scenes. For all shootings involving NYPD officers that were adjudicated between 2004 and 2006, I collected data from the NYPD Firearm Discharge Review Board documentation on all officers in the immediate vicinity of the shooting, whether or not they discharged their firearms. There were 184 shootings involving 279 shooters and 194 nonshooters adjudicated during this period. By June 1, 2007, the date all data were extracted, 79 of these officers (17%) had left the NYPD and their data had been purged. For these officers, we have no information on any of their features beside their officer ID number, giving no option but to remove them from the analysis, leaving 239 shooters and 155 nonshooters in 175 incidents.

In 51 incidents, there was only one officer on the scene and for 18 incidents all officers on the scene discharged their firearm. Without nonshooters to match with the shooters these incidents provide no information for the quantities of interest. The final analytical dataset included data on 106 shooting incidents involving 150 shooters (cases) and 141 nonshooters (controls) matched by incident.

Matching shooters and nonshooters by incident eliminates many sources of confounding. The officers included in the analysis are exactly the kinds of officers that find themselves in situations that lead to shootings—similar times, places, suspects, and calls in which officer-involved shootings occur. If the scenario had evolved differently, such as the suspect running out the back door rather than the front door or a different officer first approached the suspect, then one of the nonshooters on the scene might have become a shooter. We expect some officers in

particular instances to fire their guns out of necessity. However, if we consistently find officers with certain features are the shooters in the incident, we may be able to identify risks that can be better managed.

For each officer, the data record numerous risk factors potentially related to shooting risk. Table 1 summarizes these officer features. They include demographics, career history, performance evaluations, arrest history, sick leave, complaints, and firearm range scores. All covariates were calculated for the time of the shooting incident. Demographics include age, race, sex, and education. Work history includes hire date, rank, and command assignments.

Years at NYPD and age are highly correlated ($r = 0.76$). Including both in a regression model would complicate their interpretation. Their principal components suggest an alternative. The first principal component essentially captures longevity (older, more experience). The second principal component had higher values for older officers with less experience. This suggests using the two variables "years at NYPD" and "age recruited into the NYPD" instead. This transformation results in no loss of information (since age at the time of the shooting is the sum of years at NYPD and age when recruited), maintains interpretability of coefficients, and produces a much smaller correlation ($r = 0.32$) than the original pair of officer features.

NYPD conducts performance evaluations annually and records scores on a 0–5 scale at 0.5 point increments with higher values indicative of better performance. About 5% of officers receive the highest score and most officers, 82%, receive a score between 3.5 and 4.5. The data also include counts of meritorious awards. Forty percent of officers have at least one medal, averaging about one medal per person every 2.5 years.

NYPD's Central Personnel Index (CPI) maintains a penalty point system for certain negligent or harmful incidents. For example, auto accidents with an NYPD vehicle warrant one point. More serious incidents receive greater penalties: four points for the loss of a badge, six points for losing a firearm, and up to eight points if the officer requires special performance monitoring or receives a suspension. Firearm discharges of any kind always count for one point with the possibility of additional points for performance issues involved in the discharge. For shootings adjudicated between 2004 and 2006, the officers involved in the shootings received between 1 and 15 points with "internal investigations" being the most commonly cited reason for receiving more than 1 point for the shooting. NYPD practice has been that officers that accumulate a career total of 20 points or more are considered for performance monitoring. For this analysis, the data record the total number of CPI points accumulated by the time of the shooting, but do not include any points incurred for the shooting.

The data also include counts for work related activity, including the number of felony and misdemeanor arrests, the number of suspects previously arrested with a gun, days of injury, and illness leave (separately for injuries from line of duty and non-line of duty), the number of civilian complaints filed against the officer, and the most recent firearm requalification scores. All count features were converted to annual rates by dividing by the number of years on the job.

As would be expected, Table 1 shows for the sample of officers used in the analysis that police officers and detectives are more likely than officers in supervisory positions to be shooters.

Table 1. Comparison of shooting officers and nonshooting officers on the scene of an officer-involved shooting, New York City, cases adjudicated between 2004–2006.

		Analysis sample ^a		All shootings ^a	
		Shooting officers	Nonshooting officers	Shooting officers	Nonshooting officers
Rank ^b	<i>n</i> =	150	141	239	154
	Police officer (%)	65.3	53.2	64.9	52.6
	Detective (%)	16.0	12.8	15.9	15.6
	Sergeant (%)	16.0	24.1	16.3	22.7
	Lieutenant (%)	1.3	7.8	1.3	7.1
	Captain or higher (%)	1.3	2.1	1.7	1.9
Years at NYPD		9.0	9.4	8.9	9.3
Recruited age		24.9	25.4	25.1	25.5
Age		33.9	34.8	34.0	34.8
Race	Black (%)	21.3	15.6	20.9	16.2
	White (%)	58.7	62.4	55.6	61.0
	Other (%)	20.0	22.0	23.4	22.7
Male (%)		94.0	92.2	94.6	92.2
Education	High school (%)	20.7	17.0	21.3	17.5
	High school+some college (%)	58.7	60.3	59.0	60.4
	College (%)	19.3	20.6	18.4	20.1
	College+some graduate (%)	1.3	2.1	1.3	1.9
Command type	Precinct (%)	69.3	72.3	70.3	70.8
	Anti-crime (%)	8.7	7.1	7.9	6.5
	Detective (%)	9.3	7.1	7.1	6.5
	Narcotics (%)	6.0	6.4	7.5	9.7
	Other (%)	6.7	7.1	7.1	6.5
Evaluation score		4.0	4.1	4.0	4.1
Range score		92.5	92.7	92.7	92.9
Average annual	Number of medals	2.2	1.6	2.2	1.5
	Complaints	0.32	0.25	0.33	0.25
	CPI points ^b	1.8	1.2	1.7	1.2
	Gun arrests	1.4	1.1	1.4	1.1
	Felony arrests	5.0	4.4	4.9	4.3
	Misdemeanor arrests	6.5	6.1	6.4	6.0
	Days of sick or injury leave ^{b,c}	9.7	6.5	8.3	6.9
	Not due to line-of-duty	6.4	4.4	5.1	4.7
	Due to line-of-duty	3.3	2.1	3.1	2.2
	Administrative sick leave	1.6	1.7	1.2	1.6
Percent in excess of 3.1 CPI points/year ^b	22	7	20	8	

NOTES: ^a The “Analysis sample” column lists features of officers used in the analysis, while the “All shootings” column also includes data on officers involved in shootings in which all officers on the scene discharged their firearms.

^b Indicates a statistically significant difference at the 0.05 level using *t*-tests for continuous features and Fisher’s exact test for categorical features.

^c Average annual sick leave is based on the most recent five years.

Few other differences are observable from these marginal summaries with the exception of the CPI point accumulation rate and the sick day rate. The right two columns in Table 1 show the officer features that include both the analysis sample and officers involved in shootings in which all officers discharged their firearms. The similarity between the “analysis sample” and the “all shootings” sample suggests that results from the analysis sample will likely generalize to all officers at risk of being at the scenes of shootings in New York.

To ease interpretation and to moderate the effect of extreme covariate values, all scores and rates were replaced with an indicator as to whether the value was in the extreme 15% of the distribution. The 15% threshold was selected because it was the most extreme for which the study was still sufficiently powered to detect differences. For the results to have practical impact, thresholds associated with elevated risk can more easily translate into police policy.

3. Conditional Likelihood of Police Shootings

An officer’s shooting risk can be modeled as

$$\log \frac{P(S = 1|\mathbf{x}, \mathbf{z})}{1 - P(S = 1|\mathbf{x}, \mathbf{z})} = h(\mathbf{z}) + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \beta_d x_d \quad (1)$$

where *S* is 1 if the officer shoots and 0 otherwise, **x** are the officer’s features, and **z** are the arbitrarily complex shared features of a particular incident such as the suspects involved, suspect actions, location, and lighting. *h*(**z**) represents the baseline shooting risk of a particular scenario. The model indicates that for a unit increase in *x_j*, the odds that the officer shoots increases by a factor of exp(*β_j*).

However, the data were not collected as a random sample of (*S*, **x**, **z**) and, therefore, not consistent with a simple logistic regression approach like the one shown in (1). Instead, conditional likelihood is more compatible with the incidence density sampling approach that formed the dataset. Consider a shooting incident involving two officers, one (officer A) who fired a shot and another (officer B) who did not. This shooting incident would contribute a term to the conditional likelihood

$$P(S_A = 1, S_B = 0 | S_A + S_B = 1, \mathbf{x}_A, \mathbf{x}_B, \mathbf{z}) = \frac{e^{\beta' \mathbf{x}_A}}{e^{\beta' \mathbf{x}_A} + e^{\beta' \mathbf{x}_B}} \quad (2)$$

Conveniently, the incident features, **z**, drop out of the conditional likelihood. We can estimate the officer risk factors in (1) with only the officer features. The full conditional likelihood for the observed data is the product of similar terms, more complex for shootings with more than two officers, for each

of the shooting incidents. Maximizing the conditional likelihood produces estimates of odd ratios associated with each officer feature (Breslow et al. 1978; Rothman, Greenland, and Lash 2008). Even though we drew our samples from $P(\mathbf{x}|S = 1, \mathbf{z})$ and $P(\mathbf{x}|S = 0, \mathbf{z})$ and estimated the parameters with the conditional likelihood rather than the more typical logistic regression likelihood, the estimates of β_1, \dots, β_d from the conditional likelihood are consistent for the odd ratios of interest (Manski and Lerman 1977; Prentice and Pyke 1979). By comparing officers that have in common a scene of a shooting incident, the method completely avoids having to fully specify \mathbf{z} and avoids having to account for the baseline risk of shooting.

3.1 Contagious Fire

To simplify the conditional likelihood term as shown in (2), we must assume that, given the officers' features and the features of the scenario, the probability that an officer shoots is independent of whether the other officers shoot. Without this assumption, $h(\mathbf{z})$ does not drop out of the likelihood. Some have speculated about "contagious fire," that an officer fires because another officer on the scene has fired (Wilson 2006), although the converse is also plausible (other officers do not shoot because another officer already shot). In 75% of incidents only one officer shoots, but in the other 25% up to eight officers shoot. Contagious fire can reduce statistical power since it increases the chance that all officers on the scene shoot. Recall that 18 of the incidents in the dataset dropped out of the likelihood because all officers discharged their firearm. Even with contagion the estimated coefficients will still be in the right direction, but may have a different interpretation. That is, depending on the magnitude of contagion, the estimates may differ from the model described in (1). However, they can always be interpreted in the conditional likelihood context, given that a shooting occurs how much more likely is it that an officer with $x = 1$ is the shooter compared to an officer with $x = 0$.

Contagion's effect on the null distribution of the coefficients is more complex. To avoid relying on parametric assumptions, I used a permutation test to construct reference distributions for each parameter in the model. The permutation test randomly shuffled the shooting indicator *within each shooting incident* 10,000 times. For each permuted dataset, I refit a conditional logistic regression model. The resulting distribution of coefficient estimates is a valid reference distribution for the coefficients under the hypothesis that the covariates are unrelated to shooting risk. The permutation test p -value is computed as the fraction of simulations having the absolute value of the coefficients as or more extreme than the observed coefficient.

Research has shown that tests based on permutation p -values might not actually have the intended significance level, particularly for data with heteroscedasticity, skewness, or dependence (Modarres, Gastwirth, and Ewens 2005). I replicated the Modarres, Gastwirth, and Ewens (2005) simulation with the NYPD data, creating 1000 datasets in which the shooting outcome was unrelated to any of the features (by randomly scrambling the shooting officer indicators within each shooting) and computing a permutation p -value from a reference distribution based on

Table 2. Matched case-control analysis of shooting officers and nonshooting officers on the scene of police shootings, New York City, cases adjudicated between 2004–2006.

Variable	Odds ratio	95% interval	Permutation p -value
Rank			
Police officer (reference)			
Detective	1.2	(0.2,6.3)	0.78
Sergeant	*0.2	(0.1,0.7)	0.006
Lieutenant	*0.0	(0.0,0.4)	0.003
Captain ^a	0.1	(0.0,0.8)	0.16
Years at NYPD	1.0	(0.9,1.1)	0.89
Age when recruited	*0.9	(0.8,1.0)	0.03
Race			
White (reference)			
Black	*3.3	(1.2,8.9)	0.01
Other	1.2	(0.5,2.8)	0.71
Male	2.1	(0.5,8.9)	0.29
Education			
High school (reference)			
High school+some college	1.3	(0.5,3.0)	0.60
College	1.9	(0.6,6.1)	0.26
College+some graduate	1.8	(0.1,22.7)	0.68
Precinct officer ^b	0.2	(0.0,1.2)	0.08
Average annual			
Evaluation score < 3.5	0.7	(0.3,1.8)	0.45
Range score < 86	1.8	(0.7,4.5)	0.16
Complaints > 0.6	2.1	(0.7,6.4)	0.15
Medal count/year > 3.8	2.3	(0.5,9.5)	0.21
CPI points > 3.1	*3.1	(1.0,8.9)	0.03
Gun arrests > 2.4	0.7	(0.2,2.5)	0.64
Felony arrests > 9.3	2.1	(0.6,7.0)	0.20
Misdemeanor arrests > 10.0	*0.2	(0.1,0.6)	0.002
Days of leave			
Not due to line of duty injury > 8.4	0.9	(0.4,2.1)	0.81
Due to line of duty injury > 5.6	0.9	(0.3,2.4)	0.82

NOTES: Symbol "*" indicates a statistically significant difference at the 0.05 level.

^aAlthough the confidence interval based on normal theory does not overlap 1.0, the nonparametric permutation test p -value is well above 0.05 and, therefore, this feature is not flagged as significant.

^bPrecinct officers are assigned to precincts without special assignments (e.g., not assigned to anti-crime, detectives, housing, task forces, etc.)

10,000 random permutations. The observed significance level was within simulation error of 0.05 (between 0.036, 0.066) suggesting that the permutation p -values are robust to dependence in this dataset.

4. Data Analysis

Table 2 shows the estimated odd ratios, 95% confidence intervals, and the associated permutation p -values. For the officer features with the lowest permutation p -values in Table 2 the replication of the Modarres, Gastwirth, and Ewens (2005) simulation found these features to have observed significance levels at or below 0.05 suggesting that these p -values are conservative.

Middle management rank officers were significantly less likely than police officers to shoot ($P < 0.01$). This is reasonable as sergeants and lieutenants on the scene are much more likely to be in supervisory or command positions rather than being directly involved, although there were 24 sergeants, 2 lieutenants, and 2 captains who discharged their weapons. The confidence intervals for the odds ratio for captains based on normal theory do not overlap 1.0. However, the more reliable permutation test p -value suggests no significant difference for captains ($P = 0.16$).

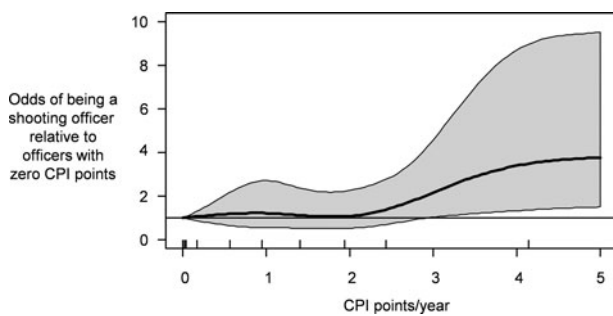


Figure 1. Relationship between an officer's CPI points per year and the odds of shooting, New York City, cases adjudicated between 2004–2006.

Officers were 10% less likely to shoot than similar officers who were 1 year younger than them when recruited ($P = 0.03$). Years of experience had no association with shooting risk. This suggests that reductions in shooting risk might be obtainable by increasing minimum age requirements or more heavily targeting police recruiting efforts toward older candidates who come to policing later in their working years.

Black officers were 3.3 times more likely to shoot than white officers ($P = 0.01$). While substantial public concern comes from shootings involving white officers and black victims, this study shows that white NYPD officers were less likely to discharge their firearms compared to black NYPD officers on the scene of the same incident. This study makes no judgment on the appropriateness of the shootings or whether the findings in New York would be consistent in other communities.

Officers accumulating more than 3.1 CPI points per year were 3.1 times more likely to be shooters ($P = 0.03$). NYPD practice has been to monitor closely officers who accumulate CPI points in excess of 20, but this analysis suggests that the rate of accumulating CPI points is a stronger indicator of shooting risk than the total number of CPI points.

The significance of CPI points is particularly relevant since it relates prior problematic performance with shooting risk. Figure 1 shows how the odds of shooting vary with the CPI points rate using a natural spline transformation of the CPI points rate. Officers with CPI point rates anywhere between 0 and 2 appear to be at no greater risk for shooting. However, above 2 CPI points per year, shooting risk appears to increase by 50% for each additional CPI point per year.

Officers who were more actively involved in making misdemeanor arrests, making more than ten misdemeanor arrests per year, were four times less likely to shoot than officers with a slower pace of misdemeanor arrests ($P = 0.002$).

5. Conclusions

This matched case-control study of 106 NYPD officer-involved shootings identified four key officer features associated with the risk of shooting.

- Officers who join NYPD later in their careers have a lower shooting risk. Several police departments have struggled with meeting recruiting objectives and have lowered the minimum age even though research has indicated that

younger officers are at higher risk for disciplinary issues (Taylor et al. 2005). The finding from this study further supports this view; recruiting older officers may reduce the frequency of police shootings.

- Black officers had more than three times greater odds of shooting than white officers. This finding runs counter to concerns that white officers are overrepresented among officers using lethal force and is consistent with several previous studies of officer race and police use-of-force. Police legitimacy requires communities to diversify their police departments to make them more representative of the citizens served. A deeper understanding of police officer race is necessary since recent research suggests diversity does not make officers safer (Barrick, Hickman, and Strom 2014) and this research does not suggest diversity will reduce the risk of police shootings.
- Officers rapidly accumulating negative marks in their file are at more than three times greater risk of shooting. This indicates that police executives aiming to ensure that their officers are not exercising unnecessary use of deadly force can monitor the accumulation negative marks as a leading indicator for shooting risk and may adopt training and assignment policies to mitigate that risk.
- Officers who made numerous misdemeanor arrests were four times less likely to shoot. This possibly suggests that frequent interaction with misdemeanor arrestees sets the officer's baseline risk of shooting lower than colleagues without that experience. Officers frequently engaged in arrests not requiring use-of-force may calibrate their perceived risk differently than other officers.

Police shootings are responsible for about 400–500 fatalities per year nationally. In addition, police shootings can greatly disrupt communities from the intangible “public trust in justice” to the tangible civil unrest and associated damage and injury. To minimize the risk of police shootings, we need a better understanding of the factors that elevate the risk of shootings. The approach used in this study relies on a conditional likelihood model to identify the association between officer features and their risk of shooting, removing potential confounding for time, place, and context of the incident. This study revealed a strong association between shooting risk and the age officers are recruited, race, officer performance, officer arrest history. This approach overcomes confounding obstacles that have undercut the conclusions of previous studies of officer-involved shootings.

This study also demonstrates that a statistical approach can address concerns about police use-of-force. In fact, other use-of-force incidents, such as conductive energy device (Tasers) usage (MacDonald, Kaminski, and Smith 2009), are more common and, therefore, will result in analyses with greater statistical power. The inclusion of additional covariates including specific types of training that officers have received or their scores on recruiting standards can help departments understand the merits of training programs and the suitability of recruiting standards. With rich data sources and appropriate statistical methodologies we can identify risks for shootings, the first step in mitigating future officer-involved shootings and heading off future civil unrest.

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References

- Barrick, K., Hickman, M. J., and Strom, K. J. (2014), "Representative Policing and Violence Towards the Police," *Policing*, 8, 193–204. [5]
- Blumberg, M. (1989), "Controlling Police Use of Deadly Force: Assessing Two Decades of Progress," in *Critical Issues in Policing*, eds. R. Dunham and G. Alpert, Prospect Heights, IL: Waveland Press, Inc., pp. 442–464. [1]
- Breslow, N. E., Day, N. E., Halvorsen, K. T., Prentice, R. L., and Sabai, C. (1978), "Estimation of Multiple Relative Risk Functions in Matched Case–Control Studies," *American Journal of Epidemiology*, 108, 299–307. [4]
- Burch, A. M. (2011), *Arrest-Related Deaths, 2003–2009: Statistical Tables*, Washington, DC: Bureau of Justice Statistics, NCJ 235385. [1]
- Centers for Disease Control and Prevention, National Center for Injury Prevention and Control (2005), "Web-Based Injury Statistics Query and Reporting System (WISQARS)." Available at <http://www.cdc.gov/injury/wisqars/index.html>. [1]
- Copeland, A. R. (1986), "Police Shootings: The Metropolitan Dade County Experience from 1956 to 1982," *The American Journal of Forensic Medicine and Pathology*, 7, 39–45. [1]
- Fyfe, J. J. (1978), *Shots Fired: An Analysis of New York City Police Firearms Discharges*, Ph.D. thesis, Albany, NY: State University of New York. [1]
- (1980), "Geographic Correlates of Police Shooting: A Microanalysis," *Journal of Research in Crime and Delinquency*, 17, 101–113. [1]
- Ho, T. (1994), "Individual and Situational Determinants of the Use of Deadly Force: A Simulation," *American Journal of Criminal Justice*, 18, 41–60. [1]
- Inn, A., Wheeler, A. C., and Sparling, C. L. (1977), "The Effects of Suspect Race and Situation Hazard on Police Officer Shooting Behavior," *Journal of Applied Social Psychology*, 7, 27–37. [1]
- Kania, R. R. E., and Mackey, W. C. (1977), "Police Violence as a Function of Community Characteristics," *Criminology*, 15, 27–48. [1]
- Knoohuizen, R., Fahey, R. P., and Palmer, D. J. (1972), *The Police and Their Use of Fatal Force in Chicago*, Chicago, IL: Chicago Law Enforcement Study Group. [1]
- Kobler, A. L. (1975), "Figures (and Perhaps Some Facts) on Police Killing of Civilians in the United States, 1965–1969," *Journal of Social Issues*, 31, 185–191. [1]
- Loflin, C., Wiersema, B., McDowall, D., and Dobrin, A. (2003), "Under-reporting of Justifiable Homicides Committed by Police Officers in the United States, 1976–1998," *American Journal of Public Health*, 93, 1117–1121. [1]
- MacDonald, J. M., Kaminski, R. J., and Smith, M. R. (2009), "The Effect of Less-Lethal Weapons on Injuries in Police Use-of-Force Events," *American Journal of Public Health*, 99, 2268–2274. [5]
- Manski, C. F., and Lerman, S. R. (1977), "The Estimation of Choice Probabilities From Choice Based Samples," *Econometrica*, 45, 1977–1988. [4]
- Matulia, K. J. (1985), *A Balance of Forces: Model Deadly Force Policies and Procedure* (2nd ed.), Gaithersburg, MD: International Association of Chiefs of Police. [1]
- Meyer, M. W. (1980), "Police Shootings at Minorities: The Case of Los Angeles," *Annals of the American Academy of Political and Social Science*, 452, 98–110. [1]
- Modarres, R., Gastwirth, J. L., and Ewens, W. (2005), "A Cautionary Note on the Use of Non-Parametric Tests in the Analysis of Environmental Data," *Environmetrics*, 16, 319–326. [4]
- Prentice, R. L., and Pyke, R. (1979), "Logistic Disease Incidence Models and Case–Control Studies," *Biometrika*, 66, 403–411. [4]
- Robin, G. D. (1963), "Justifiable Homicide by Police Officers," *Journal of Criminal Law and Criminology*, 54, 225–231. [1]
- Rostker, B. D., Hanser, L. M., Hix, W. M., Jensen, C., Morral, A. R., Ridgeway, G., and Schell, T. L. (2008), *Evaluation of the New York City Police Department Firearm Training and Firearm-Discharge Review Process (MG-717-NYPD)*, Santa Monica, CA: RAND Corporation. Available at <http://www.rand.org/pubs/monographs/MG717.html>. [2]
- Rothman, K. J., Greenland, S., and Lash, T. L. (2008), *Modern Epidemiology* (3rd ed.), Philadelphia, PA: Lippincott-Raven. [4]
- Sherman, L. W. (1980), "Execution Without Trial: Police Homicide and the Constitution," *Vanderbilt Law Review*, 33, 71–100. [1]
- (1986), *Citizens Killed by Big City Police, 1970–1984*, Washington, DC: Crime Control Institute. [1]
- Sherman, L. W., and Langworthy, R. H. (1979), "Measuring Homicide by Police Officers," *Journal of Criminal Law and Criminology*, 70, 546–560. [1]
- Smith, D. C., and Purtell, R. (2007), *An Empirical Assessment of NYPD's "Operation Impact": A Targeted Zone Crime Reduction Strategy*, NYU Wagner Graduate School of Public Service. [2]
- Takagi, P. (1974), "A Garrison State in 'Democratic' Society," *Crime and Social Justice*, 1, 27–33. [1]
- Taylor, B., Kubu, B., Fridell, L., Rees, C., Jordan, T., and Cheney, J. (2005), *The Cop Crunch: Identifying Strategies for Dealing With the Recruiting and Hiring Crisis in Law Enforcement*, Washington, DC: Police Executive Research Forum. Available at <http://www.ncjrs.gov/pdffiles1/nij/grants/213800.pdf>. [5]
- White, M. D. (2002), "Identifying Situational Predictors of Police Shootings Using Multivariate Analysis," *Policing: An International Journal of Police Strategies and Management*, 25, 726–751. [1]
- Wilson, M. (2006), "50 Shots Fired, and the Experts Offer a Theory," *New York Times*, November 27, 2006. [4]