



Identifying situational predictors of police shootings using multivariate analysis

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Abstract *Prior research on the police decision to use deadly force has tended to neglect multivariate relationships, particularly at the situational level. This paper makes use of data describing deadly force incidents in Philadelphia during two time periods (1970-1978 and 1987-1992) and employs multivariate analyses to identify situational predictors of police shootings involving gun-assaultive suspects. Findings from the multivariate analyses are then used in a pilot effort to develop predictive risk classifications of deadly force incidents. Identification of predictors of deadly force is helpful not only in assessing the relative contributions of situational variables but also in shaping our understanding of the behavior of line officers who are forced, by the nature of their work, to make split-second decisions involving life and liberty with minimal guidance and support from the police department.*

Introduction

Much of the controversy associated with deadly force centers on whether officers use it inappropriately and, if so, whether they are prone to do so based on personal attributes, in certain circumstances, against certain classes of people, and/or sometimes with the tacit approval of their employers. As a result, much police research over the last 40 years has focused on identifying the primary determinants of police shooting behavior.

Although prior deadly force research has identified three sets of potentially influential variables – environmental, organizational, and situational[1] – the relative importance of these sets of variables and their specific elements has not been clarified. Questions still remain regarding which factors or influences affect deadly force decision-making and if the significance of specific factors varies by type of incident (e.g. an incident involving a gun-assaultive suspect versus one involving an unarmed, non-assaultive suspect). Moreover, because of limitations in available data, especially at the situational level, much of the prior deadly force research has focused on simple bivariate relationships, rather than more complex and likely important multivariate relationships.

Using data describing deadly force incidents in Philadelphia during two time periods (1970-1978 and 1987-1992), this paper uses multivariate analyses to identify predictors of specific types of police shootings from a variety of situational variables characterizing these incidents. Findings are then used in a pilot effort to develop predictive risk classifications of deadly force incidents involving gun-assaultive suspects. Although the classifications are meant only to be illustrative, they highlight how the presence of certain situational



variables helps to differentiate deadly force incidents according to the type of assault against the officer. It also illustrates how more fully developed classifications could be employed to assess police-citizen encounters that have a potential to escalate to the use of deadly force.

Identification of predictors of use of deadly force is not only useful for assessing the relative contributions of situational variables, but it may also be helpful in understanding variation in police shooting behavior. In particular, the identification of factors associated with use of deadly force can help to shape our understanding of the behavior of line officers who are forced, by the nature of their work, to make decisions involving life and liberty with minimal guidance and support from the police department.

Prior research on factors influencing deadly force decision-making

Environmental determinants of deadly force

Environmental determinants of deadly force use can be separated into two basic categories:

- (1) community-level characteristics that affect police shooting behavior, such as the violent crime arrest rate, public homicide rate and population level; and
- (2) direct, external efforts to control deadly force discretion (e.g. discretion control policies such as court rulings and state laws).

Prior deadly force research has studied the impact of both types of external influences on police shooting behavior.

Community-level characteristics. Potentially violent police-citizen encounters typically occur in the community in which both participants live and/or work, and characteristics of that environment inevitably affect perceptions and behavior during the encounter (Kania and Mackey, 1977; Fyfe, 1980, 1988; Geller and Karales, 1981a; Alpert, 1989). Kania and Mackey (1977) concluded that there is a significant relationship between police violence and police exposure to violent crime. Fyfe's (1980) analysis of reported New York City police shootings from 1971-1975 showed that the police shooting rates were positively correlated with violent crime arrest rates and public homicide rates, as well as with threats to police and general public safety (Fyfe, 1980). Fyfe (1982), Geller and Karales (1981a), Alpert (1989) and Jacobs and O'Brien (1998) have also found a positive association between levels of community violence and police shooting behavior.

Sherman and Langworthy (1979) examined community characteristics and organizational variables among selected cities over a three-year period and found strong relationships between police shootings, the violent crime rate and the homicide rate. Liska and Yu (1992) also found a relationship between levels of community violence and levels of deadly force. Matulia (1985) examined the 57 largest US cities and found positive correlations between use of deadly force by police and several measures of community violence, such as homicides, UCR crimes, robberies, police officers murdered and justifiable homicides by private

citizens. Matulia (1985) concluded that police shooting rates were affected more by the level of violence in the community than any other factor, including organizational policy.

Alternatively, other researchers have posited a “conflict model”, suggesting that police are more likely to use deadly force against:

... persons who live outside the American mainstream, particularly members of minorities (Sorensen *et al.*, 1993, p. 417).

Jacobs and Britt (1979) applied conflict theory to the use of deadly force and found support for the hypothesis that police are most likely to use deadly force when economic inequality and conflict are greatest (Jacobs and Britt, 1979). Sorensen *et al.* (1993) examined both the “conflict” and “community violence” hypotheses and found a strong relationship between levels of economic inequality (and proportion of minorities) and deadly force incidents. Sorensen *et al.* (1993) found a relationship between violent crime rates and use of deadly force but concluded that violent crime often acts as an intervening variable for other social variables:

Our analysis makes clear that economic inequality and the proportion of minorities in the population must be included in any future studies which attempt to explain the rate of police-caused homicide at the macro level (Sorensen *et al.*, 1993, p. 439).

Direct external control efforts. External efforts to control deadly force decision-making have met with varying degrees of success. State statutes regarding justifiable homicide can limit police use of deadly force, but Fyfe (1988) noted that the law is too vague regarding appropriate and acceptable behavior by police. Waegel’s (1984) analysis of 459 police shootings in Philadelphia from 1970-1978 shows that, despite a major change in the Pennsylvania statute governing use of deadly force in 1973 (prohibiting shots to apprehend non-violent felony suspects), 20 percent of the shootings violated legal standards (see also White, 1999)[2].

Judicial intervention has, on occasion, been an effective control for police shooting behavior. In 1985, the Supreme Court ruled in *Tennessee v. Garner*, 471 US 1, that deadly force is a constitutional means of effecting an arrest only when a felony:

... suspect threatens the officer with a weapon or there is probable cause to believe that he has committed a crime involving the infliction or threatened infliction of serious physical harm (*Tennessee v. Garner*, 471 US at 4).

Tennenbaum (1994) examined the effects of the *Garner* decision on use of deadly force nationwide and concludes that it reduced the number of police killings by 60 homicides a year (a 16 percent decrease)[3].

In *Lyons v. Los Angeles*, 461 US 95, Adolph Lyons challenged the Los Angeles Police Department’s (LAPD) use of the carotid control hold technique for subduing citizens in non-life threatening situations[4]. Although the court ruled against Lyons, the LAPD subsequently re-defined the carotid control hold

as a use of deadly force, rather than a pain compliance hold (Skolnick and Fyfe, 1993).

Organizational determinants of deadly force: administrative policy

Although police officers spend the majority of their time working without direct supervision, prior research demonstrates that formal and informal characteristics of the police organization – mostly notably administrative policy – significantly influence their behavior during violent citizen encounters (Reiss, 1968, 1980; Fyfe, 1979, 1988; Blumberg, 1989; Geller and Scott, 1992).

Up until the last 25 years, most departments gave their officers little guidance regarding when to use deadly force. The President's Commission on Law Enforcement and the Administration of Justice (1967) expressed its concern over the absence of administrative guidance regarding deadly force. Implementation of more practical and restrictive deadly force policies in the 1970s and 1980s allowed for a wealth of social research studying its effects on the prevalence and frequency of deadly force incidents. In 1972, for example, the New York City Police Department created new, more restrictive guidelines governing the use of deadly force, and Fyfe (1978, 1979) examined the impact of that directive on the frequency, nature, and consequences of police shootings from 1971-1975. His analysis shows significant decreases in both the use of deadly force and in officer injury and death following implementation of the restrictive policy (Fyfe, 1979). Administrative policies demonstrated similar effects on police shooting behavior in Oakland, Omaha, Kansas City, Los Angeles, Dallas, Philadelphia and Memphis (Gain, 1971; Fyfe, 1988; Geller and Scott, 1992).

Fyfe (1988) subsequently concluded that organizational philosophies, expectations, and policies heavily influence the use of deadly force, and levels of community violence and variations in the law only marginally affect police shooting behavior (see also Reiss, 1980; Blumberg, 1989). Walker (1993, p. 32) noted:

These data support the conclusion that administrative rules have successfully limited police shooting discretion, with positive results in terms of social policy. Fewer people are being shot and killed, racial disparities in shootings have been reduced, and police officers are in no greater danger because of these restrictions. Officers appear to comply with the rules. This is an accomplishment of major significance and one that provides a model for other discretion control efforts.

Situational determinants of deadly force

The literature typically shows that the majority of suspects who are shot or shot at present a real and imminent danger to the police (Robin, 1963; Binder and Scharf, 1980; Fyfe, 1980, 1981a; Kobler, 1975a, b; Margarita, 1980; Binder and Fridell, 1984). Kobler (1975a) stated that in nearly 75 percent of the cases he examined, the victim (suspect shot by police) had some sort of weapon, and the officer stated that he/she resorted to the use of deadly force either to defend him/herself against imminent danger or to prevent the escape of a known felon

or suspect (see also Fyfe, 1978; Geller and Karales, 1981a, b; 1982; Horvath, 1987; Horvath and Donahue, 1982; New York State Commission on Criminal Justice and the Use of Force, 1987, Cerar, 1990; Geller and Scott, 1992).

Binder and Scharf (1980) asserted that two characteristics that increase the likelihood of police violence are the actual or perceived threat to the police and citizen disrespect[5]. Blumberg's (1989) analysis of the deadly force literature indicated that officer age and length of service are linked to shooting behavior, although Fyfe (1978) found no such relationship in New York. Friedrich (1980) showed that the behavior of the offender (i.e. demeanor toward police) and the visibility of the situation to peers and the public are both significant influences on the use of force.

The literature consistently shows that shooting victims are disproportionately African American. Robin's (1963) data showed that, during the 1950s, the shooting rate of black suspects was at a rate seven times higher than whites. According to Takagi's analysis of coroner data from 1960-1968, American police:

... killed 1,188 black males and 1,253 white males in a population in which about ten percent are black (Takagi, 1974, p. 29).

In the seven cities studied by Milton *et al.* (1977), 79 percent of shooting victims were black. Fyfe's (1981b) analysis of New York City police shootings from 1971-1975 showed that the rate at which police fired at black males was six times greater than the rates for white and Hispanic males. Geller and Karales (1981b) found that 70 percent of those killed by Chicago police from 1974-1978 were black.

Such disproportionality continues to fuel debate. Goldkamp (1976) proposed two perspectives to explain this disproportionality: first, disproportionality could result from differential police practices (i.e. one "trigger finger" for white suspects, and another for black suspects (Takagi, 1974)); second, blacks may be disproportionately involved in violent crime and other activities which increase the likelihood of their being shot. Fyfe (1982) applied Goldkamp's perspectives to his comparison of police shootings in New York and Memphis, and the results indicated that Goldkamp's first perspective (police shooting behavior varies by suspect race) was in operation in Memphis from 1969-1976. Meyer's (1980) study of police shootings in Los Angeles also demonstrated that shootings differ in number, circumstance, and in the review process for blacks as compared with whites and Hispanics. In Los Angeles, less stringent standards existed for shootings of blacks than of whites, with shootings of unarmed whites receiving official condemnation significantly more often than shootings of unarmed blacks (Meyer, 1980).

Alternatively, Matulia (1985) found that blacks, though disproportionately represented among police shooting victims, were also more likely to be engaged in activities likely to get them shot: blacks comprised 66 percent of homicide arrestees, 71 percent of robbery arrestees, and 64 percent of those arrested for violent crimes. Other studies have shown that most victims of police shootings

are male with a median age of 24-25, which is consistent with the characteristics of persons most likely to be engaged in criminal conduct (Fyfe, 1978; Knoohuizen *et al.*, 1972; Kobler, 1975a; Robin, 1963). Research on police as victims of violence indicates that, in many cases, it is the suspect's actions, rather than race, which lead to a violent outcome (Margarita, 1980).

Research does not conclusively support either of Goldkamp's (1976) perspectives. Given that police officers work in so many different environments (organizational and otherwise), the relationship between race and deadly force likely varies across jurisdictions. Therefore, researchers must examine and understand the environmental, organizational and situational influences on the police. Also, the circumstances surrounding those shootings must be examined, such as:

- the victim's actions;
- the officer's actions;
- the type of assault against the officer;
- the type of weapon involved; and
- the other options available to the officer in addition to resorting to deadly force.

By breaking down the police-citizen encounter into several decision-making stages, research illustrates the importance of earlier situational decisions made by police and demonstrates how those early decisions affect subsequent ones (Binder and Scharf, 1980; Geller and Karales, 1981a; Bayley, 1986; Fyfe, 1986; 1989). Bayley (1986) demonstrated that decisions made at earlier stages clearly affect decisions made later in the encounter[6].

Binder and Scharf (1980) characterized five important decision phases in police/citizen encounters:

- (1) anticipation;
- (2) entry and initial confrontation;
- (3) dialogue and information exchange;
- (4) final frame decision; and
- (5) aftermath.

At each phase of the encounter, the police officer and the citizen make decisions and respond to the decisions of the other participant (see also Fyfe's (1986) discussion of the "split-second syndrome"). Binder and Scharf concluded:

A police "decision" to use, or not to use, deadly force in a given context might be better described as a contingent sequence of decisions and resulting behaviors – each increasing or decreasing the probability of an eventual use of deadly force (Binder and Scharf, 1980, p. 116)[7].

Fyfe (1987) argued that environmental, organizational and situational variables comprise the external and internal police working environments. The external

environment includes factors outside of the police organization (environmental variables, see earlier discussion), as well as situational variables (Fyfe, 1987). The internal working environment refers to factors within the police organization (e.g. administrative policy, informal peer group norms, policies and philosophies of the chief, etc.) (Fyfe, 1987).

White (1999, 2001) modified Fyfe's (1987) conceptualization of police working environments by treating situational variables as a distinct category of influences that play a critical role in the decision-making process. White (1999, 2001) found that the relative importance of internal and external working environments and situational variables varies based on the nature of the shooting incident. Specifically, the type of assault and amount of danger facing the officer mediates the degree of influence of each. The internal and external working environments play a more prominent role in encounters where the suspect is unarmed and the degree of danger facing the officer is low (in comparison to incidents involving armed suspects), while situational factors are less important. In encounters with armed suspects (where the level of danger is presumably greater), however, situational factors largely dictate an officer's decision to use deadly force and outweigh the relative influence of the working environments (White, 1999, 2001).

However, prior research has not clarified or agreed upon the relative importance of these factors and their specific elements in police use of deadly force. Many variables reflecting aspects of both types of police working environments and situational characteristics demonstrate some effect on police deadly force decision-making, but these effects are neither consistent nor powerful. Moreover, deadly force research that studies the impact of change within the police working environments on levels of deadly force (whether it be direct or unintentional) tends to rely on bivariate analyses and to overlook the importance of situational variables (e.g. Gain, 1971; Kania and Mackey, 1977; Waegel, 1984). Upon an exhaustive review of the literature at that time, Sherman (1980) concluded that the bivariate relationships examined by prior research are generally weak, and he suggested focusing more attention on alternative approaches such as studying multivariate relationships. Since then, this has often been precluded by weaknesses in available data sources and inadequate research designs that limit researchers' ability to conduct multivariate analyses, particularly at the situational level. Consequently, understanding of the situational determinants of deadly force use is still rather general, with many specific questions remaining unanswered.

This paper makes use of data describing deadly force incidents in Philadelphia during two time periods (1970-1978 and 1987-1992) to identify situational predictors of shootings of gun-assaultive suspects; encounters where situational determinants are most influential (see White (2001) for a more detailed discussion of the role of working environments). Multivariate analyses using logistic regression and CHAID examine the role of specific situational variables, and findings are then used in a pilot effort to develop predictive risk classifications of deadly force incidents involving gun-assaultive suspects. The

illustrative development of predictive classifications of police shootings demonstrates how such techniques can be applied to police field behavior and can help to guide officers' decision-making in potentially violent citizen encounters.

Data and methods

This research examines Philadelphia police shooting data from two time periods, 1970-1978 and 1987-1992. The data were coded directly from Philadelphia Police Department Internal Shooting Investigations obtained through discovery in civil litigation. Reports for the intervening years, 1979-1986, could not be located. In the first time period (1970-1978), there are 644 injurious deadly force incidents. Police shootings where there were no injuries (i.e. missed shots) were not systematically reported or investigated by PPD during this time period, and as a result are not part of the 1970-1978 analysis[8]. From 1987-1992, PPD investigated all firearms discharges, regardless of injury, and the data from that period include 357 shootings (164 injurious, and 193 non-injurious; 46 percent of shootings hit their target; 54 percent did not). Because of this fundamental difference in the police shooting data across time, the paper does not merge the time periods for a combined analysis.

Data involving police-citizen encounters not resulting in deadly force were not available for analysis. Although the utility of these analyses are challenged by the lack of a comparable sample of non-deadly force encounters, the author believes that deadly force incidents are special cases of police-citizen encounters that, in many ways, can be studied and understood in a manner similar to less violent and nonviolent encounters. Notably, almost all police-citizen encounters, especially those that are adversarial, have the potential to end in violence because of the officer's monopoly on the legitimate use of force (see Bittner, 1970). Also, all encounters can be broken down into a series of decisions and responses made by both participants with each action either increasing or decreasing the likelihood of a violent outcome (Toch, 1969; Binder and Scharf, 1980; Bayley, 1986; Fyfe 1986; Bayley and Garofalo, 1989). Nonviolent encounters can quickly become violent and, perhaps less frequently, violent encounters can quickly become nonviolent. Under this model, we can apply the same conceptual framework to all police-citizen encounters, regardless of outcome. That is, the influences of the same types of factors within the internal and external police working environments are mediated through the situation and affect officers' decision-making and, in great measure, determine whether an encounter will result in less-than-lethal force, deadly force, or no force at all.

A danger-based typology is used to differentiate shootings by estimating the amount of danger facing the officer (i.e. threat to officer's safety). Specifically, the typology arranges shootings based on the type of assault/weapon and degree of potential lethality, and has been used in prior research (Fyfe, 1978; 1981b; 1982; 1987; Geller and Karales, 1981a). The study assigns each shooting

a classification on the danger-based typology. The typology, in descending order of lethality, is as follows:

- (1) *Gun/assault*: shootings at assaultive suspects armed with guns.
- (2) *Knife/assault*: shootings at assaultive suspects armed with knives or other cutting instruments.
- (3) *Other/assault*: shootings at assaultive suspects armed with other weapons (i.e. cars, clubs, chains, etc.)
- (4) *Physical/assault*: shootings at suspects who, alone or in groups, have assaulted police officers or others by use of unarmed physical force.
- (5) *Non-assaultive*: shootings at suspects who are unarmed and non-assaultive (Fyfe, 1981a).

This typology resembles similar continua or scales developed by police agencies across the country as training tools for the use of force. As one moves from top to bottom on the typology, the danger facing the police officer generally decreases. Importantly, these classifications are not absolute. There are many instances where police officers are confronted with armed suspects who pose an immediate threat and deadly force is not used. Similarly, there are instances where deadly force is used against suspects who are unarmed and present little or no threat to police[9].

Multivariate analyses using logistic regression and CHAID (Chi-squared Automatic Interaction Detector) then further examine the role of situational variables on the decision to use deadly force, during each period of time[10]. Logistic regression is a flexible modeling strategy that predicts the probability that some event will happen (Hamilton, 1992). The CHAID method performs segmentation modeling and accomplishes the same goal but relies on different assumptions and properties (Magidson, 1993). In this case, the research attempts to develop predictive models for shootings of gun-assaultive suspects in the two time periods (1970-1978 and 1987-1992).

Output from the logistic regression and CHAID models are then used to develop predictive classifications of low, medium, and high risk that a particular shooting will occur. The goal of this part of the analysis plan is to identify combinations of factors that increase the likelihood of use of deadly force. Results can be compared across time periods to identify common themes or factors that are consistently associated with a greater likelihood of police shootings of gun-assaultive suspects.

The dependent variable: shootings involving gun-assaultive suspects

The danger-based typology allows for the dependent variable (police shootings) to be defined a number of different ways[11]. The conceptions of the dependent variable that likely are of greatest practical and theoretical interest are those that isolate gun-assaultive and non-assaultive suspects. Although incidents involving gun-assaultive suspects are the likeliest to result in deadly

force and to be legally (and departmentally) justifiable, they are relevant because, with extremely rare exceptions, they represent incidents where the officer's life is in immediate danger[12]. By isolating gun assaults, the analyses give attention to those police-citizen encounters that consistently represent the greatest threat to officers' safety. Moreover, White (1999; 2001) highlights the importance of situational variables (the focus of the analysis) for presumptively non-elective deadly force incidents, such as those involving gun-wielding suspects.

Also of particular interest is the conception of the dependent variable that separates shootings of non-assaultive suspects. Although identifying predictors of shootings of non-assaultive suspects is important, the results are not presented here because the small number of such cases in the later time period ($n = 12$) restricted the analyses[13]. As a result, multivariate analyses will be used to identify predictors of shootings of gun-assaultive suspects only.

The independent variables

The independent variables in the analysis include officer-, suspect- and situational-related variables from each incident, and they serve as the pool of potential variables associated with the dependent variable (gun-assaultive deadly force incidents). Independent variables were selected because of their theoretical and experiential significance[14].

Table I shows variation in selected attributes of incidents (independent variables) over time. All of the independent variables are situational and play a potentially important role in determining whether an officer uses deadly force, particularly in encounters involving armed suspects (see earlier review of the literature). Table I shows that many of the independent variables changed little over time. A few notable changes include increases in the later time period in the percentage of non-white officers using deadly force, the percentage involving "man with gun" calls, and the percentage of incidents where both the officer and suspect are non-white; and decreases in citizen-initiated incidents (i.e. radio calls), and those involving robbery.

Analysis and results

Multivariate analysis of deadly force in Philadelphia, from 1970-1978 and 1987-1992

Logistic regression models were developed for the dependent variable, gun-assaultive incidents, in each time period separately. CHAID analysis, also employed with data from each time period separately, begins with the dichotomous dependent variable (gun assault versus not a gun assault) and splits the population of cases at successive stages based on criteria such as statistical significance, magnitude of the relationship with the dependent variable, and the number of cases remaining (Magidson, 1993). Additionally, CHAID measures interactions among predictors that highlight an increased association with values of the dependent variable.

	1970-1978 (n = 644)		1987-1992 (n = 357)	
	%	n	%	n
<i>Officer characteristics</i>				
Gender				
Male	99.5	638	94.1	336
Female	0.5	3	5.9	21
Total	100.0	641	100.0	357
Race				
White	72.4	451	55.5	198
Non-white	27.6	172	44.5	159
Total	100.0	623	100.0	357
Mean age	30.6	606	34.8	357
Duty status				
On-duty	81.0	521	73.9	264
Off-duty	19.0	122	26.1	93
Total	100.0	643	100.0	357
<i>Suspect characteristics</i>				
Gender				
Male	98.3	632	97.7	347
Female	1.7	11	2.3	8
Total	100.0	643	100.0	355
Race				
White	17.5	109	13.6	48
Non-white	82.5	514	86.4	306
Total	100.0	623	100.0	354
Mean age	25.5	630	26.3	309
<i>Situational characteristics</i>				
Incident type – man with gun				
No	91.1	587	80.1	286
Yes	8.9	57	19.9	71
Total	100.0	644	100.0	357
Incident type – robbery				
No	74.7	481	84.9	303
Yes	25.3	163	15.1	54
Total	100.0	644	100.0	357
Incident type – disturbance				
No	89.1	574	95.5	341
Yes	10.9	70	4.5	16
Total	100.0	644	100.0	357
How officer became involved				
Radio call	42.6	274	33.9	121
Officer-initiated	57.4	369	66.1	236
Total	100.0	643	100.0	357
Officer/suspect race				
Other	84.0	524	88.2	315
White officer/white suspect	16.0	100	11.8	42
Total	100.0	624	100.0	357
Officer/suspect race				
Other	74.0	460	57.4	205
Non-white officer/non-white suspect	26.0	162	42.6	152
Total	100.0	622	100.0	357

Table I.
Selected attributes of
police shootings in
Philadelphia, 1970-1978
and 1987-1992

(continued)

	1970-1978 (n = 644)		1987-1992 (n = 357)	
	%	n	%	n
Officer/suspect race				
Other	44.0	273	56.9	203
White officer/non-white suspect	56.0	348	43.1	154
Total	100.0	621	100.0	357
Officer/suspect race				
Other	98.7	617	98.3	351
Non-white officer/white suspect	1.3	8	1.7	6
Total	100.0	625	100.0	357
Number of officers present				
One	39.5	249	39.6	141
More than one	60.5	381	60.4	215
Total	100.0	630	100.0	356

Table I.

LOGIT with police shootings of gun-assaultive suspects

Using a pool of over 20 situational variables, logistic regression models predicting police shootings of gun-wielding suspects were developed for each time period[15]. In 1970-1978, five variables increased the likelihood of a deadly force incident involving a gun-assaultive suspect. The strongest predictor of the dependent variable involved incidents where police responded to a “man with gun” call. Not surprisingly, “man with gun” incidents predicted shootings of gun-wielding suspects. Two other types of incidents were associated with an increased likelihood of a shooting of a gun-assaultive suspect: those involving robberies and those involving disturbances. Also, police shootings of gun-assaultive suspects were more likely to occur if the officer was searching for or confronting the suspect, and if both the officer and suspect were non-white. Alternatively, incidents that had progressed further into the encounter with the officer and suspect already engaged, and those involving inter-racial officer/suspect combinations (or where both were white) were less likely to result in gun-assaultive deadly force incidents.

In the later time period (1987-1992), three predictors from the 1970-1978 analysis remain significantly associated with the dependent variable: incidents involving man with gun and robbery calls, and incidents where the officer is searching the scene or confronting the suspect. Also, incidents where more than one officer is present and incidents that are officer-initiated (not officers responding to radio calls) are associated with a greater probability of resulting in a shooting of a gun-wielding suspect[16]. Recall that the later data includes all firearms discharges, regardless of outcome, while the earlier data only includes those resulting in injury or death. The common themes among predictors, despite the differences in data and the passage of time, suggest that predictors of deadly force incidents involving gun-wielding suspects may be relatively constant across outcome and time (see Table II).

Predictors (significance)	1970-1978 Coefficient (significance)	1987-1992 Coefficient (significance)
Incident type – man with gun (no, yes)	4.204 (0.000)	3.291 (0.000)
Incident type – robbery (no, yes)	1.543 (0.000)	1.364 (0.000)
Officer actions prior to shooting ^a	0.873 (0.000)	1.212 (0.000)
Incident type – disturbance (no, yes)	0.851 (0.002)	–
Intra-racial incident (other, non-white officer and non-white suspect)	0.513 (0.015)	–
Number of officers present (one, more than one)	–	0.917 (0.001)
How officer got involved (radio call, observation/advised by civilian)	–	0.633 (0.026)
Constant	–2.581	–3.684
Model χ^2	163.335	119.368
Df	5	5
Df significance	0.000	0.000
Overall percentage correct	72.2	72.2
–2 Log likelihood	677.179	370.507
<i>n</i>	622	356

Table II.

Logistic regression models predicting Philadelphia police shootings involving gun-assaultive suspects, 1970-1978 and 1987-1992, by time period

Note: ^aFor 1970-1978, officer actions prior to shooting are categorized as 0=other, 1=approaching vehicle, searching scene, confronting suspect, resolving dispute. For 1987-1992, officers actions prior to shooting are categorized as 0=other, 1=searching scene, attempting arrest, confronting suspect. Although the variable was constructed differently in the two sets of analyses, there were common officer actions that were associated with use of deadly force against gun-assaultive suspects (e.g. searching the scene and confronting the suspect) in both time periods

Examining shootings of gun-assaultive suspects with CHAID

CHAID divides a population (in this case, police shootings in Philadelphia) into segments that differ based on a specific variable (gun-assaultive or not a gun-assaultive shooting), called segmentation modeling (Magidson, 1993):

CHAID divides a population into two or more distinct groups based on categories of the “best” predictor of a dependent variable. It then splits each of these groups into smaller subgroups based on other predictor variables. This splitting process continues until no more statistically significant predictors can be found (or until some other stopping rule is met) (Magidson, 1993, p. 3).

The resulting segments are “mutually exclusive and exhaustive”, and cases can be classified by identifying the specific values of predictors that defined the splits (e.g. simply tracing the segment back up the CHAID tree) (Magidson, 1993, p. 3). Then, end segments (or groups of police shootings with the same predictors) with similar values of the dependent variable can be classified into risk categories, resulting in a risk classification scheme similar to that created using logistic regression (and its predicted values).

CHAID considers all of the independent variables used in the logistic regression analysis, and selects (either automatically or manually) those most significant (see Figures 1 and 2). In Figure 1 for 1970-1978, the gun-assaultive

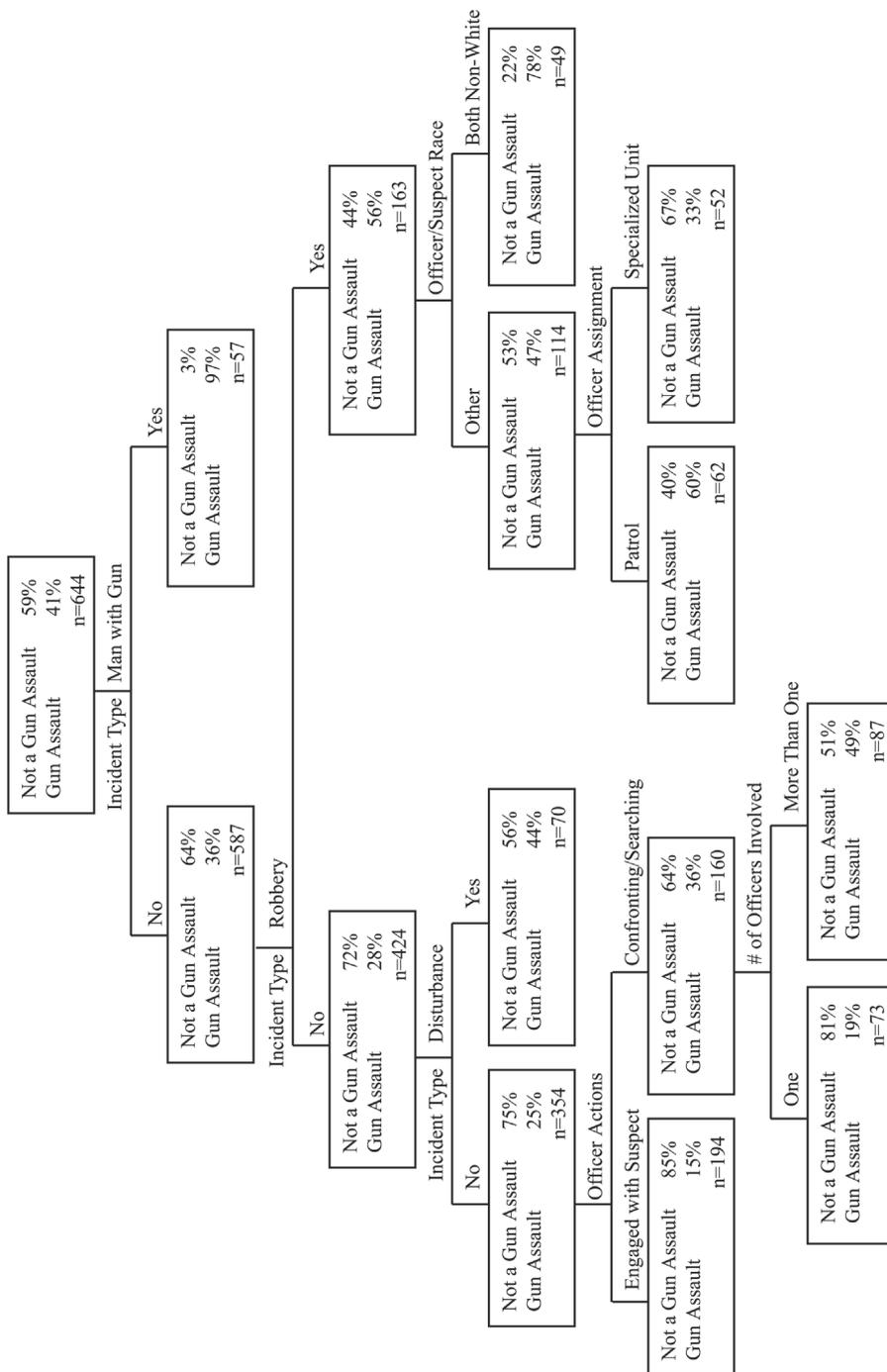


Figure 1.
CHAID analysis with
deadly force incidents
involving gun-assaultive
suspects in Philadelphia,
1970-1978



Figure 2. CHAID analysis with deadly force incidents involving gun-assaultive suspects in Philadelphia, 1987-1992

dependent variable, gun assault or not a gun assault, is at the top of the CHAID tree. A total of 41 percent of all shootings in the 1970-1978 data involved gun-assaultive suspects. Similar to the logistic regression analyses, the initial split is made on “man with gun” incidents: 97 percent of man with gun calls (that resulted in police shootings) involved a gun-wielding suspect, compared to 36 percent of other types of deadly force incidents. Additional splits are made on robbery and disturbance incidents (both with an increased probability of the dependent variable), officer/suspect race interaction (both non-white with an increased probability), officer actions (confronting suspect/searching scene with an increased probability), officer assignment (traditional patrol with an increased probability), and number of officers present (more than one officer present with an increased probability). The predictors of deadly force incidents involving gun-assaultive suspects in 1970-1978 were nearly identical in logistic regression and CHAID analyses.

Table III shows the eight termination cells for the 1970-1978 CHAID analysis, including their characteristics, size, and percentage of the dependent variable. Man with gun calls show the greatest association to the dependent variable (96.5 percent), followed by robbery calls where both the officer and suspect are non-white. Incidents with the lowest probability of resulting in a gun-assaultive deadly force incident include those not involving man with gun, robbery, or disturbance calls, where there is only

End group	Description	<i>n</i>	% of total	% of dependent variable	Risk level
Gun assaults					
1	Incident type, man with a gun	57	8.5	96.5	High
2	Incident type, robbery; officer and suspect non-white	49	7.6	77.6	High
3	Incident type, robbery; not non-white officer and suspect; officer assigned to district patrol	62	9.6	59.7	High
4	Incident type, not robbery, disturbance or man with gun; officer confronting suspect or searching scene; more than one officer present	87	13.5	49.4	Medium
5	Incident type, disturbance	70	10.9	44.3	Medium
6	Incident type, robbery; not non-white officer and suspect; officer assigned to specialized unit	52	8.1	32.7	Medium
7	Incident type, not robbery, disturbance or man with gun; officer confronting suspect or searching scene; one officer present	73	11.3	19.2	Low
8	Incident type, not robbery, disturbance or man with gun; officer engaged with suspect	194	30.1	15.5	Low
Total		644	100.0		

Table III.
Summary of CHAID end groups for deadly force incidents involving gun-assaultive suspects, 1970-1978

one officer present, and where the encounter has progressed to later stages (beyond initial contact).

The CHAID analyses for 1987-1992 are shown in Figure 2. A total of 55 percent of all shootings during the later time period involved gun-wielding suspects. Initial splits are made on man with gun and robbery incident types, as well the number of officers involved and officer actions. Table IV shows the five termination cells, with man with gun calls posing the greatest risk of a gun-assaultive police shooting. Similar to the 1970-1978 analyses, factors that decrease the probability of the dependent variable include incidents not

End group	Description	<i>n</i>	% of total	% of dependent variable	Risk level
Gun assaults					
1	Incident type, man with a gun	71	19.9	94.4	High
2	Incident type, robbery	54	15.1	68.5	Medium
3	Incident type, not robbery or man with gun; officer confronting suspect or searching scene; more than one officer present	88	24.7	55.7	Medium
4	Incident type, not robbery or man with gun; officer engaged with suspect; more than one officer present	55	15.4	36.4	Low
5	Incident type, not robbery or man with gun; one officer present	89	24.9	27.0	Low
Total		357	100.0		

Table IV.
Summary of CHAID end groups for deadly force incidents involving gun-assaultive suspects, 1987-1992

involving a man with a gun or robbery, those where only one officer is present, or those that have progressed to later stages of the encounter.

There is substantial consistency among predictor variables for both CHAID and logistic regression, including the type of incident, officer behavior prior to the shooting, the number of officers involved, and an intra-racial combination where both participants are non-white[17]. Importantly, this consistency is found across time despite fundamental differences in the data from 1970-1978 and 1987-1992; that is, the later data (1987-1992) includes all firearms discharges regardless of outcome or injury, while the earlier data (1970-1978) includes only those resulting in injury or death. This finding suggests that the reliance on only injurious shootings during 1970-1978 does not necessarily weaken the study, and, perhaps importantly, indicates that the predictors of shootings of gun-wielding suspects do not vary by the outcome of the deadly force incident (e.g. accuracy of the shooter in hitting his or her target)[18].

More generally, findings suggest that several situational variables play an important role in the decision to use deadly force against gun-assaultive suspects. Importantly, these findings indicate that, over time, certain types of incidents (whether they be calls for service, or officer-initiated) are predictive of shootings of gun-wielding suspects, as are certain types of police officer actions. The types of incidents associated with the dependent variable are not overly surprising, since at least two of three incident types frequently involve suspects armed with guns (man with gun and robbery calls). The significance of multiple officers as a predictor likely stems from the types of calls that are associated with shootings of gun-assaultive suspects. In particular, multiple officers are likely to respond to man with gun and robbery calls because of the potential seriousness of the incident.

The findings also suggest that police are more likely to shoot gun-wielding suspects at the initial contact stage (see e.g. Binder and Scharf, 1980; Bayley, 1986), as they approach a scene or confront a suspect. Deadly force incidents that progress into later stages of the encounter (dialogue exchange, attempting arrest, physical struggle) are much less likely to involve gun assaults against the officer. The significance of how the officer became involved (radio call vs officer-initiated) in the later time period may also be related to the sequence or timing of the encounter. Specifically, officers who proactively engage suspects are more likely to begin the encounter at a critical stage, when the suspect is focused on the commission of a crime, rather than on escape. Beginning the police-citizen encounter at a more critical stage may increase the likelihood of violent action by the suspect and, in turn, a violent response by the officer.

The emergence of an intra-racial officer/suspect combination as a predictor of police shootings involving gun-assaultive suspects in the 1970-1978 period represents an important relationship that may partially explain the over-representation of black males as police shooting victims in Philadelphia during that time (see Table I; 83 percent of police shooting victims were black). Findings here suggest that the over-representation is at least partially a result

of over-involvement in activities likely to lead to police shootings (gun assaults against police). The relationship with officer race may be a consequence of assignment, residence and socialization patterns among non-white Philadelphia police officers. That is, non-white officers likely patrol areas populated by non-white citizens, and they may tend to live in areas populated by non-white citizens (see Fyfe, 1981a).

There are a few possible explanations for this finding. First, perhaps non-white officers and white officers experienced gun assaults equally but non-white officers used deadly force more often as a response to the assault. This seems unlikely given that gun assaults generally place the officer's life in imminent danger, and deadly force is typically a justified response in such an encounter. Second, non-white officers may simply experience a higher percentage of gun-assaultive deadly force incidents than white officers. Perhaps, as Fyfe (1981a) has reported, non-white officers police areas of the city where these types of encounters are more likely to occur. Without comparison data involving gun assaults that did not end in deadly force, it is impossible to draw conclusions regarding the relationship between officer and suspect race, or to determine why it was not a predictor in later years, but their interaction clearly played an important role in predicting gun-assaultive police shootings from 1970-1978.

Predicting police shootings of gun-assaultive suspects

Results from the multivariate analyses permit the development of risk classifications for police shootings of gun-assaultive suspects. These classifications are meant to be illustrative, demonstrating how the probabilities of certain outcomes are associated with important officer-, suspect-, and incident-related variables, rather than concrete statements about how all potentially violent police-citizen encounters will likely end[19]

Using models from both time periods, risk classification schemes were developed according to "B weight" values from the logistic regression output and by tracing the values associated with splits in the CHAID tree. In CHAID, termination cells with similar percentages of the dependent variable were grouped to construct a three-level risk classification of gun-assaultive deadly force incidents. Logistic regression results were used to calculate a predicted value for each incident[20]. Predicted values were then grouped into three distinct risk levels. An effective predictive instrument creates separate and distinct risk levels, consisting of groupings of incidents with attributes ranking them.

Table V shows the risk models for gun-assaultive incidents based on results from logistic regression and CHAID. For 1970-1978, the logistic regression model produced three risk levels, with the low level experiencing gun assaults in 16 percent of the cases, medium level in 38 percent of the cases and the high level in 75 percent of the cases. A total of 31 percent of the cases are classified as low risk, 43 percent as medium risk, with the remaining 26 percent as high risk of a gun-assaultive deadly force incident. The CHAID classification for

Model type and risk level	<i>n</i>	%	Total actual % of gun-assaultive deadly force incidents
<i>Logistic regression model</i>			
1970-1978			
Low risk	190	30.5	15.8
Medium risk	270	43.4	37.8
High risk	162	26.0	74.7
Total	622	100.0	
1987-1992			
Low risk	67	18.8	20.9
Medium risk	137	38.5	40.1
High risk	152	42.7	83.6
Total	356	100.0	
<i>CHAID model</i>			
1970-1978			
Low risk	267	41.5	16.5
Medium risk	209	32.5	43.5
High risk	168	26.1	77.4
Total	644	100.0	
1987-1992			
Low risk	144	40.3	30.6
Medium risk	142	39.8	60.6
High risk	71	19.9	94.4
Total	357	100.0	

Table V.
Risk classification models for Philadelphia police shootings involving gun-assaultive suspects, 1970-1978 and 1987-1992

1970-1978 performs just as well with three distinct, sizeable levels with percentages of the dependent variable that range from 17 percent for low risk, 44 percent for medium risk, and 77 percent for high risk[21].

For 1987-1992 data, similarly effective predictive classification schemes are produced from both types of analyses. For logit, three levels are created, with 21 percent of low risk cases, 40 percent of medium risk cases, and 84 percent of high risk cases actually experiencing shootings of (or at) gun-wielding suspects. The CHAID classification highlights one-fifth of the cases that have an exceptionally high risk of resulting in a shooting of a gun-assaultive suspect (94 percent), with larger low and medium risk levels (40 percent each) experiencing the dependent variable in 31 percent and 61 percent of the cases, respectively.

Although these risk classifications are not meant to be definitive, they demonstrate how the presence of specific situational variables increases the likelihood of a gun-assaultive deadly force incident. Additional research will begin to isolate more definitively important predictors of such outcomes, will determine whether those predictors vary by jurisdiction, and may possibly influence department training and policy. Although the findings here certainly do not allow for such changes in training and policy, they do represent a step in that direction. Eventually, research in this area could lead to the development of specific guidelines for responding to and resolving “high -risk” gun-assaultive encounters. Much like general deadly force, arrest, and hot pursuit policies,

“high-risk” use of deadly force policies would provide officers with specific information and guidance intended to control their discretion, decrease risks to their personal safety and the safety of others, and increase the likelihood of resolving potentially violent incidents with a minimum use of force.

Discussion and conclusions

The analyses in this paper sought to identify situational predictors of deadly force incidents involving gun-assaultive suspects. Shootings of gun-assaultive suspects were selected because situational determinants play a more influential role in police shooting behavior during encounters involving armed and dangerous suspects (White, 1999; 2001). Through the identification of predictors of use of deadly force, the researcher sought to assess the relative contributions of situational variables and to understand variation in police shooting behavior.

Several officer-, suspect-, and incident-related variables emerge as important independent variables and help to clarify which situational factors are primary determinant uses of deadly force against gun-assaultive suspects. Importantly, the analyses found substantial consistency in the predictors of the dependent variable across time and analytic technique, despite fundamental differences in the data. The consistency across time and analysis indicates strong predictive relationships and underscores the value of their identification for anticipating violent outcomes in encounters involving gun-wielding suspects.

In both time periods and in both types of multivariate analysis, the type of incident surfaced as a critically important predictor. Clearly, there are categories of events that display an elevated risk of ending in a gun-assaultive deadly force incident, most notably man with gun, robbery and disturbance incidents. The association between multiple officers on the scene and gun-assaultive deadly force incidents likely results from the tendency (or department policy) for several officers to respond to incidents involving armed suspects and robbery. Also, the analyses consistently show that shootings of gun-wielding suspects are more likely to occur during the early stages of the encounter, highlighting the importance of what police officers do prior to engaging the suspect. Fyfe (1986) suggests that officers may structure their confrontations in ways likely to reduce the possibility of escalation to deadly force by, for example, approaching them in tactically sophisticated ways that take advantage of territorial knowledge and available concealment or cover.

Moreover, prior deadly force research establishes that police-citizen encounters involve a number of important decision-making stages, and the final outcome is a culmination of those earlier decisions made by both participants (Binder and Scharf, 1980; Geller and Karales, 1981a; Bayley, 1986; Fyfe, 1986, 1989). The officer may have the ability to influence the encounter to reduce the likelihood of a violent outcome, even before he or she has engaged the suspect (i.e. by using concealment), and training and administrative guidance are critically important factors in educating officers about such techniques and behavior (Fyfe, 1986).

Last, incidents involving both non-white suspects and officers (intra-racial) emerged as a significant predictor of gun-assaultive deadly force incidents. Other officer-suspect racial combinations, as well as suspect race alone, were not associated with the dependent variable. The issue of suspect race is particularly important in Philadelphia because of the style of policing and resulting civil litigation that marked the 1970s (i.e. *Rizzo v. Goode*, change in Pennsylvania state law governing justifiable homicide). Despite the well-documented “bust-their-heads”[22] police style of PPD during this time, findings here suggest that the disproportionate percentage of black male shooting victims is at least partially a consequence of their involvement in gun assaults against PPD officers, especially non-white officers, rather than discriminatory shooting practices involving white officers and black suspects[23].

Nearly two decades ago, Sherman (1980) considered the lack of attention to multivariate relationships a major weakness in deadly force research, but little work has focused on this area since then, particularly at the situational level of analysis (see also, Liska and Yu, 1992; Sorenson *et al.*, 1993; Jacobs and O’Brien, 1998). The analyses presented here sought to re-focus attention on this weakness in the literature. In doing so, the analyses support a number of findings from prior deadly force research, in a sense, confirming their importance (i.e. the need for administrative policy and training to guide officers’ approaches to potentially violent encounters; and the types of encounters likely to escalate to deadly force). The application of multivariate techniques at the situational level here also serves to more fully investigate a number of unanswered questions and/or controversial issues, including the role of officer and suspect race (in Philadelphia during the “Rizzo” years), and the number of officers involved.

This study also made a first attempt at applying risk prediction to police shooting behavior. In doing so, it placed special emphasis on interactions among important situational determinants. Both logistic regression and CHAID performed well in identifying distinct risk classifications for Philadelphia police shootings of gun-assaultive suspects. Although the classifications are meant only to be illustrative, they highlight how the presence of certain variables help to differentiate deadly force incidents according to the type of assault against the officer. They also illustrate how more fully developed classifications could be employed to assess police-citizen encounters that have a potential to escalate to the use of deadly force. As work continues in this area, research will begin to refine the predictors of shootings, and researchers will be able to work with practitioners to improve training, policies and procedures to guide officer behavior in high-risk deadly force encounters.

Notes

1. See Fyfe (1988) for an extensive discussion of the factors that influence police use of deadly force.
2. Waegel (1984) did not account for the abolition of a restrictive departmental deadly force policy in December 1974.

3. This effect is both direct (Garner reduced the number of shootings at fleeing felons) and indirect (the Supreme Court decision influenced departments to develop policies more restrictive than the constitutional minimum, in order to appear sensitive to the public) (Tennenbaum, 1994).
4. Before the United States Supreme Court, Lyons' attorneys successfully argued that, in the five years prior to his encounter with LAPD (in which he was rendered unconscious by a chokehold after being stopped for a traffic violation), 16 people died as a result of the carotid control hold, which is "twice as many chokehold-related deaths as the combined total of the other 20 largest US police departments" (Skolnick and Fyfe, 1993, p. 42).
5. Although police do not generally shoot citizens for being disrespectful, officers who are poorly trained and led to believe that they will not be held accountable for a lack of caution in their work may be more likely to become involved in shootings than more skilled, accountable officers.
6. For example, in a disturbance encounter, passive listening at contact led to verbal advice at exit, but physical restraint at contact led to arrest at exit.
7. Geller and Scott (1992, p. 326) note that the Binder-Scharf model is missing a critical phase between the dialogue/information exchange and final frame decision, which they labeled "use of non-lethal tactics". Regardless of the degree of specificity in the varying decision models, there is general consensus among scholars regarding the importance of early decisions, and how police can use those early decisions to reduce the likelihood of a violent outcome (Geller and Scott, 1992).
8. Essentially, there is no record of police use of deadly force among PPD officers from 1970-1978, unless the shooting resulted in injury or death.
9. The classification is determined on the basis of the police officer's perspective during the incident. As a result, if the suspect's weapon is a metallic object thought to be a gun, the incident is coded as a gun assault (even if the metallic object is subsequently found to have been a screwdriver).
10. A bivariate analysis is used to reduce the pool of potentially influential variables.
11. For example, the dependent variable could be defined as:
 - DV1: 1 = gun assault; 0 = knife, other weapon, physical and non-assault;
 - DV2: 1 = gun or knife assault; 0 = other weapon, physical and non-assault;
 - DV3: 1 = gun, knife, other weapon assault; 0 = physical and non-assault; and
 - DV4: 1 = gun, knife, other weapon and physical assault; 0 = non-assault.
12. Although each conception of the dependent variable is defined by the type of assault against the police officer, each assault type has a gray line, or margin of error within it. For example, there are some gun-assaultive incidents that are elective (e.g. the OJ Simpson "low-speed" chase) and physically assaultive incidents that are non-elective (e.g. when the officer is greatly outnumbered, or if he or she is about to lose consciousness). Rather than making subjective decisions regarding how elective a shooting decision was, the author relies on the more objective measure based on assault type and acknowledges a small degree of error.
13. In 1970-1978, there were 141 shootings of non-assaultive suspects; in 1987-1992, there were only 12. The decrease of those types of shootings is likely the result of changes in police policy and practice during the intervening years. The early time period is characterized by heavy-handed police tactics in resolving police-citizen encounters, often times involving the officer's firearm. The brutal and excessive behavior of Philadelphia police officers during the 1970s stemmed from an organizational tolerance of such conduct that filtered down from both the offices of the mayor and police commissioner (see Fyfe, 1988; White,

2000; 2001). In 1980, the new reform mayor promptly hired a police commissioner who set about making dramatic organizational changes, including restrictive administrative guidelines governing use of deadly force. Prior research shows that these organizational changes dramatically altered PPD's use of deadly force, and the administrative policy's influence is reflected in the analyses here as well (see also Fyfe, 1988; White, 2000; 2001).

14. Many other variables have been coded on each incident, but they have been excluded from this analysis either because of non-significant findings from the bivariate analysis or because of their lack of theoretical or operational significance. The pool of predictor variables is limited to those with theoretical or practical implications to ensure that the analyses produce meaningful and valuable results.
15. The pool of predictors was reduced using a bivariate analysis, thus identifying variables likely to produce meaningful results that significantly contribute to the model.
16. How the officer became involved (radio call vs officer-initiated) is not significantly related to the dependent variable at the bivariate level, suggesting that there may be an interaction between that variable and another predictor during the later time period.
17. Differences between findings from logistic regression and CHAID are attributed to the different assumptions and properties of the two methods.
18. Whether or not the shooter hit the target (injurious or non-injurious) was included in the 1987-1992 analyses as an independent variable but it was found to be unrelated to the dependent variable.
19. A more comprehensive predictive analysis would validate the predictive models either by applying them to different samples or by split-half construction and validation, or some other appropriate technique. Given the small sample sizes, validation was not attempted here.
20. The equation used to calculate predicted logit scores for 1970-1978 is:

$$\text{Gun-assaultive} = -2.581 + (4.204 \times \text{guncall}) + (1.543 \times \text{robbery}) + (0.873 \times \text{copact2}) + (0.851 \times \text{disturb}) + (0.513 \times \text{intarac2}).$$
 The equation for 1987-1992 is:

$$\text{Gun-assaultive} = -3.684 + (3.291 \times \text{guncall}) + (1.212 \times \text{copact2}) + (0.917 \times \text{nocops2}) + (1.364 \times \text{robbery}) + (0.633 \times \text{gotjob3}).$$
21. Both predictive schemes isolate 26 percent of the cases as high risk. Logit and CHAID models do differ on the classification of the remaining 75 percent of cases as low and medium risk.
22. Police commissioner (and subsequently mayor) Frank Rizzo described his style of policing and treatment of criminals as "*spacco il cappa*", or "to bust their heads" (*The Philadelphia Inquirer*, 1991).
23. Additional analyses with shootings of non-assaultive suspects support this finding. Results show no relationship between suspect race and non-assaultive incidents. In fact, CHAID determined that both participants being black is associated with a low risk of a non-assaultive shooting.

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