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Effectiveness of Taxicab Security Equipment in Reducing Driver Homicide Rates

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Abstract

Background—Taxicab drivers historically have had one of the highest work-related homicide rates of any occupation. In 2010 the taxicab driver homicide rate was 7.4 per 100,000 drivers, compared to the overall rate of 0.37 per 100,000 workers.

Purpose—Evaluate the effectiveness of taxicab security cameras and partitions on citywide taxicab driver homicide rates.

Methods—Taxicab driver homicide rates were compared in 26 major cities in the U.S. licensing taxicabs with security cameras (n=8); bullet-resistant partitions (n=7); and cities where taxicabs were not equipped with either security cameras or partitions (n=11). News clippings of taxicab driver homicides and the number of licensed taxicabs by city were used to construct taxicab driver homicide rates spanning 15 years (1996–2010). Generalized estimating equations were constructed to model the Poisson-distributed homicide rates on city-specific safety equipment installation status, controlling for city homicide rate and the concurrent decline of homicide rates over time. Data were analyzed in 2012.

Results—Cities with cameras experienced a threefold reduction in taxicab driver homicides compared with control cities (RR=0.27; 95% CI=0.12, 0.61; p=0.002). There was no difference in homicide rates for cities with partitions compared with control cities (RR=1.15; 95% CI=0.80, 1.64; p=0.575).

Conclusions—Municipal ordinances and company policies mandating security cameras appear to be highly effective in reducing taxicab driver deaths due to workplace violence.

Introduction

Workplace violence remains a leading source of occupational fatalities and injuries[1] with taxicab drivers historically experiencing one of the highest homicide rates of any

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Supplementary data

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occupation.[2] Since the mid-1990s, workplace homicides have declined in the general working population.[3] However, homicide rates among taxicab drivers continue to rank among the highest of any occupation.[2] Despite a tremendous need for effective safety advances in this occupation, there is a paucity of research focused on evaluating the effectiveness of safety equipment in taxicabs.

Two safety publications[4,5] that summarized risk factors for work-related homicides have guided the taxicab industry and its regulators in the use of safety equipment to prevent workplace violence. In the past 20 years, the use of safety equipment in taxicabs occurred through ordinances promulgated by municipal transportation regulators or policies issued by large companies. Bullet-resistant partitions were the dominant safety equipment in use in the early 1990s. Currently, cameras are in greater use and have become the security equipment of choice for industry regulators and taxicab fleet operators.

Although a comprehensive evaluation of interventions designed to reduce robberies in the retail industry has been undertaken,[6] there have been to date only two reports examining the effectiveness of taxicab safety equipment in reducing workplace violence outcomes.[7,8] (In 1999, transportation researchers reported a 56% decrease in assaults after 12 months of mandatory partition installation in a pilot group of taxicab drivers.[7]) Further, taxicab drivers with partitions experienced fivefold fewer assaults than taxicab drivers without partitions.[7]

Subsequently, a comprehensive report in 2004 presented case studies for two cities using cameras in taxicabs and claimed the use of cameras resulted in decreases in both robberies and assaults.[8] Although both reports presented data supporting the use of partitions and security cameras as effective in reducing assaults, the findings were based on a short time period and a single city's experience. Evaluating workplace violence incidents among taxicab drivers in multiple cities over a shared, longer time span would contribute to this limited body of research and provide stronger conclusions and generalizability of the findings.

The study objective was to evaluate the effectiveness of safety equipment in reducing taxicab driver homicide rates. Specifically, it was hypothesized that installing cameras in taxicabs resulted in a reduction in citywide taxicab driver homicide rates (1) post-installation and (2) in comparison to cities without cameras. Second, it was hypothesized that cities with partitions installed in taxicabs experienced reduced taxicab driver homicide rates compared with cities without partitions.

Methods

A city was selected for inclusion in the analysis based on the following criteria: (1) being the most populated city within a metropolitan statistical area (MSA) with a population >250,000 and (2) maintaining taxicab licenses or playing a formal role in taxicab regulation. A list of the most-populated metropolitan statistical areas in the U.S. was generated from the U.S. Census Bureau.[9] One major city within each MSA was identified for every MSA on the list. If there was only one city for an MSA, data for that city were collected. Cities meeting

Criteria 1 and 2 that did not have a substantial taxicab presence as determined by the city regulator were excluded in the evaluation.

Homicide data were retrieved by conducting a Lexis-Nexis Boolean search designed to locate electronically published newspaper reports during 1996 through 2010 describing taxicab driver homicides, using the following algorithm: 'cabdriver or cab driver or cabbie or (taxi w/2 driver) or livery driver or (limo! w/2 driver)' w/15 dead or death or die or died or dies or slay! or slain or kill! or murder! or fatal! or mortal!) and 'and not compiled by or obit! or subject (jury trial or mistrial or testimony or sentencing or verdict or decisions rulings or settlements or decisions)'. The *and not* section was designed to exclude articles on ongoing litigation. Each article was reviewed for duplication by trained data extractors. Data extracted on each taxicab driver who was ascertained to be a homicide victim were recorded for subsequent aggregation. To check for completeness, the name and date of each taxicab driver homicide was compared with a comprehensive list (www.taxi-library.org) memorializing the drivers created and maintained by a taxicab driver[10] in addition to verifying each city's homicides with the city transportation regulator.

Taxicab driver homicide rates consisted of the number of taxicab driver homicides (news clippings) divided by the number of licensed taxicabs (provided by municipal transportation regulators). Licensed taxicabs included medallions, liveries, and paratransit but excluded shuttles. Unauthorized taxicabs or taxicabs with expired vehicle licenses were excluded to the extent possible. Transportation regulators also described the type of security equipment installed in taxicabs (cameras, partitions, or neither) and provided the year most city taxicabs, if any, were installed with the security equipment. City homicide rates per 100,000 population were obtained from the annual Uniform Crime Reports published by the U.S Federal Bureau of Investigation (FBI) and represented the background crime rates for each MSA.[11]

All data elements were recorded annually by city, spanning the years 1996 through 2010. Safety equipment was indicated by two mutually exclusive dichotomous variables—safety cameras or partitions—and was recorded annually according to installation status in the majority of taxicabs. A city was considered a "camera city" if more than 70% of the taxicabs were equipped with cameras. Similarly, a city was considered a "partition city" if more than 70% of the taxicabs were equipped with partitions. A "control city" was defined as having less than 10% of the taxicabs equipped with either a camera or a partition. These cut-points were used as they represent the distribution of safety equipment implemented as a company policy for cities without ordinances mandating safety equipment.

A retrospective longitudinal time-series analysis was employed to evaluate the association of safety equipment type with taxicab driver homicide rates. The outcome variable was city taxicab driver homicide rate. The main effect independent variables were safety equipment type. Safety equipment status for each dichotomous variable representing safety equipment type was designated "1" beginning in the first full year safety equipment was implemented. In each city, the use of safety cameras or partitions was mutually exclusive. There were no lag periods created, as it was not expected that there would be a delayed effect of security equipment on taxicab driver homicide rates. A variable designating calendar year was

included to control for the declining trend in homicide rates among taxicab drivers that began prior to 1996.[3]

All data were collected and analyzed in 1-year increments, with city being the analytic unit. Analyses were conducted in 2012 using PROC GENMOD in SAS, version 9.2. Generalized estimating equations were used to account for the serial correlation of the time series and allow for the clustering of data within cities. The natural logarithm of the number of licensed taxicabs by city each year was used as an offset variable.

The taxicab driver homicide counts were assumed to follow a Poisson distribution; the offset variable provided the denominator used to calculate the homicide rates. The data were tested for dispersion and found to be slightly under-dispersed (scale=0.9), so that all reported CIs can be considered conservative in their range. Annual city-specific taxicab driver homicide rates were modeled on camera installation status to test the hypothesis that cities with cameras experienced a decline in taxicab driver homicide rates compared to cities with neither cameras nor partitions. The Wald test statistic determined significance.

The same statistical model, restricted to camera cities, was used to test for the reduction in taxicab driver homicide rates post-installation compared with pre-installation. Taxicab driver homicide rates were modeled on partition installation status to test whether the hypothesis cities with partitions experienced lower taxicab driver homicide rates compared to cities with neither cameras nor partitions. The timing of the partition installations relative to the years examined precluded analysis of homicide rates post-installation versus pre-installation.

Results

Taxicab Driver Homicide Distribution

News clippings data on the annual number of taxicab driver homicides, the annual number of licensed taxicabs, and city homicide rate were obtained for 26 cities. Taxicabs in eight cities were equipped with security cameras, taxicabs in seven cities had partitions installed, and 11 cities served as controls as they had neither partitions nor cameras installed. The camera and partition cities included in the analysis represent all of the cities eligible for the study. Table 1 presents the cities included in the analysis, their primary safety equipment designation, and, if applicable, the year and circumstance of widespread camera or partition installation. Cameras were installed in four of the camera cities due to a company policy, and four cities passed an ordinance mandating camera installation. Only one of the partition cities installed partitions during the time period evaluated in the study.

During the 15-year study period, news clippings identified 216 taxicab driver homicides in the 26 cities included in the analysis. The average number of taxicab driver homicides was 14 per year, with the minimum being three homicides (2007) and the maximum 24 (1997, 1998). Table 2 delineates the number of taxicab driver homicides per city and year, classified according to safety equipment status. Also included are the average number of licensed taxicabs per city, the average taxicab driver homicide rate per city, and the average homicide rate per city.

Figure 1 depicts the annual rate of taxicab driver homicides according to safety equipment type (neither cameras nor partitions is indicated as “control”). The taxicab driver homicide rates for partition cities and control cities were very similar for almost every year examined, peaking in 1998 and 2010. In general, the camera cities pre-installation experienced lower homicide rates than the partition cities, although for 2002 through 2004, homicide rates in camera cities were the highest of any of the groups. Finally, homicide rates in camera cities post-installation appeared to be lower for the majority of years than rates in camera cities pre-installation for comparable years.

Examining only the camera cities allows for a pre- and post-installation comparison of the number of taxicab driver homicide rates for each city (Figure 2). For every city, the taxicab driver homicide rate decreased post-installation. All of the cities with ordinances mandating cameras had no taxicab driver homicides after installation of cameras.

Effect of Cameras on Taxicab Driver Homicide Rates

Model 1 in Table 3 tests Hypothesis 1a that taxicab driver homicide rates post-installation of cameras were lower than those pre-installation. The unadjusted effect of camera installation in reducing taxicab driver homicide rates was significant (RR=0.18, 95% CI=0.08, 0.43). After controlling for an annual change in taxicab driver homicide rates (“year”) and city homicide rate, the effect of camera installation remained significant (RR=0.14, 95% CI=0.07, 0.29). Model 2 describes the effect of camera installation compared to control cities (Hypothesis 1b). Both the unadjusted and adjusted effects of camera installation compared to control cities were significantly associated with reduced rate ratios: 4.8 times lower rates when unadjusted and 3.7 times lower rates after adjusting for annual taxicab driver homicide rate changes and city homicide rate (Table 3).

Effect of Partitions on Taxicab Driver Homicide Rates

The effect of partition installation compared to control cities (Hypothesis 2) found no significant association between citywide partition installation and taxicab driver homicide rates either before or after adjusting for annual taxicab driver homicide rate changes and city homicide rates (RR_{unadj}=1.01, 95% CI=0.64, 1.59; RR_{adj}=1.15, 95% CI=0.80, 1.64).

Discussion

These data support the hypothesis that installing cameras in taxicabs results in a reduction in citywide taxicab driver homicide rates post-installation (seven times lower homicide rate) and compared to cities with neither cameras nor partitions (three times lower homicide rate). The data do not support the hypothesis that cities with partitions installed in taxicabs experience lower taxicab driver homicide rates than cities with neither cameras nor partitions. This is the first study to methodically collect data from a nationally representative sample of the largest taxicab cities over a 15-year time span that allows for comparison of rates pre- and post-installation of cameras.

Cameras are effective to the extent that they are used to their optimal performance and publicized. The ordinance requirements in some cities mandate that a decal be posted on the passenger windows to make passengers aware that they are under surveillance. Consistent

with Crime Prevention Through Environmental Design Theory, would-be perpetrators are less likely to commit a crime while under surveillance.[12]

Another crucial component to ensure optimal performance of security cameras is maintaining cameras according to manufacturer's instructions and not allowing security cameras to be intentionally disabled. Security cameras mandated by ordinance are checked for functioning at yearly inspections organized by city regulators, if not more frequently, when taxicab vehicles are checked for safety. Two of the three taxicab driver homicides that occurred in camera cities in 2010 had disabled cameras in their taxicabs (International Association of Transportation Regulators, personal communication, 2011). Specifically, the only city that experienced an increase in number of homicides after camera installation (City 4) was the city with the two murdered taxicab drivers whose cameras were disabled.

All six taxicab driver homicides post-installation occurred in camera cities where cameras are required by company policy instead of by city ordinance. Although company policies for security camera installation may be effective, municipal ordinances requiring that all taxicabs be equipped with operating security cameras may be more effective. Such ordinances would ensure that individual owner–operated taxicabs and smaller businesses would use cameras, as do the nationally recognized taxicab companies that make up a large share of the market. Because deterrence through identification is one effect of camera installation, it is important that news reports mention the presence of a camera in the taxicab of a murdered driver, and post photos of potential suspects, so that potential perpetrators are aware of the possibility of being identified by surveillance cameras.

The lack of an observed reduction in taxicab driver homicides in partition cities was unexpected. Partitions were implemented citywide because of ordinance requirements before 1996 in six of the seven cities examined. These were typically the cities that were experiencing the highest number of taxicab driver homicides, and also the highest crime rates in the sample. The benefit of the bullet-resistant partition, consistent with Situational Crime Prevention Theory, is that it is designed to give more power to the driver than to the passenger in regard to control of physical space. Additionally, it separates the target (cash held by driver) from the perpetrator.[12,13]

The news reports provided only partial information on location of the shooting relative to the taxicab—on average, 30% of these data were missing. For those news reports that provided the information, on average, 75% of reported locations were *inside* the taxicab. Details about whether they occurred because of an open partition or through the back of the driver's seat are difficult to obtain, yet important for understanding the limitations of partitions.

One suggestion for improving the effect of partitions may be to incorporate complementary safety features, such as signage indicating that minimum amounts of cash are carried by the driver, accompanied by installation of a cashless system, and GPSs for driver location.[4,5] Although there was not an observed or significant reduction in taxicab driver homicides because of partitions alone, partitions could confer a protective effect in combination with additional safety measures. At this time, it is only speculation to decide which additional

safety measures are needed, and further research evaluating additional safety measures for taxicab drivers is warranted.

Limitations

This study is limited by its ability to confer risk to individual taxicab drivers. Thus, because of the ecologic study design, the change in taxicab driver homicide rates (or lack thereof) in response to various types of safety equipment can be attributed only to citywide homicide rates. It is not possible to speak to the individual risks of taxicab drivers who have cameras versus partitions versus neither. However, this is a well-designed ecologic analysis that included all the major taxicab cities in the U.S. over a 15-year time span to allow for observed sustainable effects; it also incorporated a pre–post intervention with comparison group study design. The present study was conducted in response to a request by the International Association of Transportation Regulators, and the observations and findings of this research have implications for taxicab driver homicides in other countries where such homicide rates are considerably higher.

Another potential limitation is under-reporting when using news reports in constructing an outcome measure. News reports on work-related homicides where police officers, convenience store clerks, and taxicab drivers are the victims tend to be well documented in electronic media. The search strategy used in the current study is methodologically rigorous and was conducted within a comprehensive electronic database. The results were validated by municipal taxicab regulators and were compared with data received from police departments for a separate phase of the overall study (covering 20 of the cities).

An additional limitation is the use of secondary safety equipment, such as GPS devices that geographically track the taxicab, and alert devices were not included as potential covariates. These data were very difficult to obtain in order to record them annually, as most regulators do not document when they install secondary safety equipment. However, most of the cities have taxicabs equipped with GPS devices and alerts, and the use of secondary safety equipment is not predominantly associated with camera or partition cities.

Conclusion

The data suggest that citywide installation of security cameras in taxicabs may result in a sustainable reduction of the homicide rate among taxicab drivers. The current results are likely generalizable to countries with similar issues of taxicab safety and similar taxicab driver robbery and assault risk factors. Current research is planned to evaluate the effect of cameras in reducing robbery and assault rates by interviewing individual drivers.

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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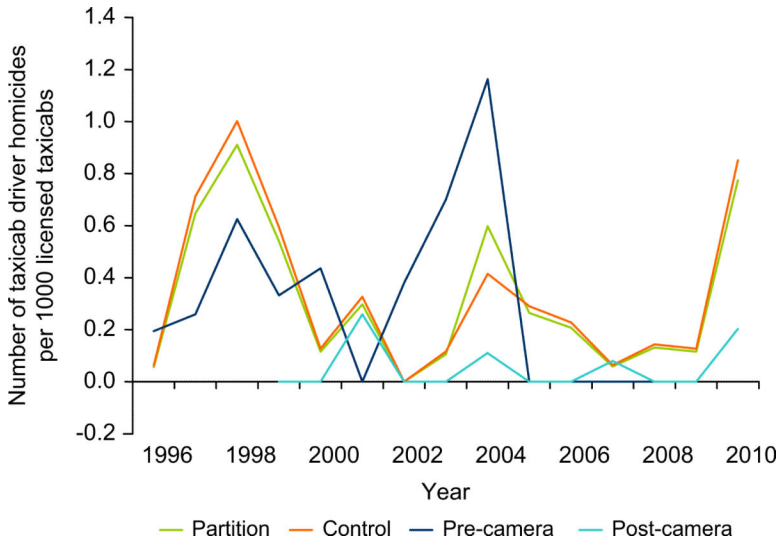

Figure 1.

Distribution of taxicab driver homicide rates by safety equipment for cities included in analysis, U.S., 1996–2010

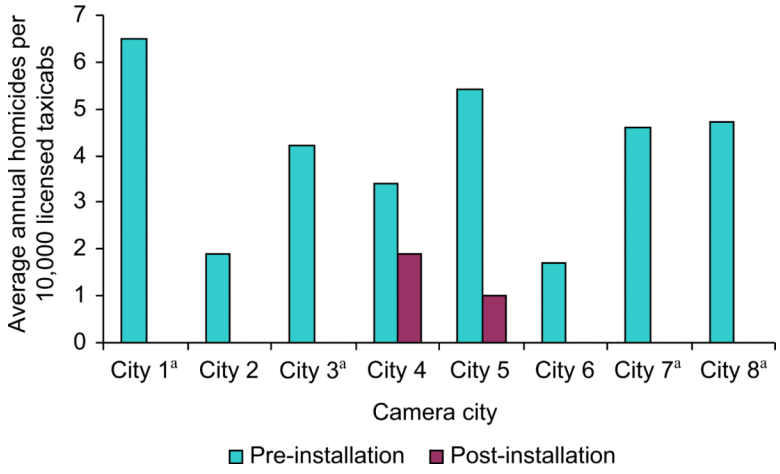

Figure 2.

Taxicab driver homicide rates for camera cities pre- and post-installation, U.S., 1996–2010

Note: There were no fatalities post-installation for Cities 1, 2, 3, 6, 7, and 8. Actual number of homicides for each period are indicated above each column.

[a]Cities with an ordinance mandating cameras

Table 1

Distribution of safety equipment by study cities: U.S., 1996-2010

Camera cities (year installed)	Partition cities[b] (year installed if after 1996)	Control cities
Austin TX (2005)	Baltimore MD (1999)[c]	Atlanta GA
Dallas TX (1999)	Boston MA	Cincinnati OH
Houston TX (1999)	Chicago IL	Columbus OH
Las Vegas NV (2005)[a]	Detroit MI	Denver CO
Orlando FL (2009)	Los Angeles CA	Honolulu HI
Portland OR (2004)[a]	New York City NY	Miami FL
San Francisco CA (2003)[a]	Philadelphia PA	New Orleans LA
Seattle WA (2006)[a]		Reno NV
		Sacramento CA
		San Diego CA
		Tampa FL

[a] Citywide camera installation per ordinance requirement

[b] All partition cities have citywide installation.

[c] Baltimore is the only partition city that did not have partitions installed before 1996.

Table 2

Distribution of taxicab driver homicides by city and per year, U.S., 1996-2010

	Number of taxicab driver homicides															Average number of licensed taxicabs	Average taxicab driver homicide rate[a]	Average city homicide rate[b]
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010			
Cameras																		
City 1[c]	—	—	—	—	1	—	—	1	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	382	0.35	2.7
City 2	—	—	—	—	—	—	—	—	1	—	—	—	—	__[d]	__[d]	449	0.16	5.5
City 3[c]	—	—	1	1	—	—	—	1	1	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	1,422	0.25	10.2
City 4	—	1	1	__[d]	__[d]	1[d]	__[d]	__[d]	1	__[d]	__[d]	__[d]	__[d]	__[d]	2[d]	2,092	0.19	8.7
City 5	—	1	2	1	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	1[d]	__[d]	__[d]	1[d]	1,861	0.21	8.0
City 6	—	—	1	—	—	—	—	—	—	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	669	0.10	3.7
City 7[c]	—	1	1	1	—	—	1	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	1,353	0.22	5.6
City 8[c]	1	—	—	—	—	—	1	—	1	—	__[d]	__[d]	__[d]	__[d]	__[d]	648	0.31	3.3
Partitions																		
City 9	3	2	1	1[d]	2[d]	2[d]	__[d]	1[d]	1[d]	1[d]	2[d]	1[d]	__[d]	2[d]	1[d]	1,400	0.95	14.4
City 10	—d	2[d]	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	__[d]	1[d]	__[d]	__[d]	__[d]	__[d]	__[d]	1,685	0.12	3.8
City 11	1[d]	5[d]	4[d]	__[d]	3[d]	2[d]	__[d]	2[d]	1[d]	3[d]	1[d]	__[d]	__[d]	__[d]	__[d]	6,646	0.22	7.1
City 12	__[d]	__[d]	__[d]	1[d]	__[d]	__[d]	__[d]	__[d]	1[d]	1[d]	__[d]	__[d]	__[d]	__[d]	__[d]	750	0.27	16.7
City 13	__[d]	__[d]	__[d]	3[d]	1[d]	3[d]	1[d]	1[d]	—d	__[d]	1[d]	__[d]	__[d]	__[d]	__[d]	2,169	0.31	10.2
City 14	14[d]	5[d]	4[d]	4[d]	11[d]	4[d]	5[d]	2[d]	3[d]	4[d]	1[d]	__[d]	3[d]	3[d]	2[d]	12,517	0.35	6.6
City 15	__[d]	2[d]	__[d]	__[d]	1[d]	1[d]	1[d]	3[d]	__[d]	__[d]	1[d]	__[d]	1[d]	__[d]	1[d]	1,650	0.44	10.4
Control																		
City 16	—	—	1	1	1	1	—	1	—	—	2	1	—	1	1	1,548	0.43	8.8
City 17	—	—	—	1	—	—	—	—	1	1	—	—	—	—	2	462	0.76	5.8
City 18	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	500	0.27	6.5
City 19	—	—	1	—	—	—	1	—	1	—	—	—	—	—	—	821	0.28	4.7

	Number of taxicab driver homicides															Average number of licensed taxicabs	Average taxicab driver homicide rate[a]	Average city homicide rate[b]
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010			
City 20	—	—	—	2	—	—	—	—	—	—	1	—	—	—	1	2,000	0.13	2.3
City 21	—	—	2	1	—	—	—	1	1	1	1	—	3	—	—	1,945	0.34	10.0
City 22	1	5	1	1	1	1	—	—	2	—	—	—	—	1	1	1,600	0.58	25.2
City 23[e]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	250	0.27	4.7
City 24	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	332	0.36	5.5
City 25	—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	915	0.23	3.7
City 26[e]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	577	0.00	5.1

[a] Per 1000 taxicabs

[b] Per 100,000 city population

[c] Cities with ordinance mandating taxicab cameras

[d] Designate year of camera or partition implementation

[e] These cities did not experience any taxicab driver homicides during the time span studied.

Table 3

Statistical models describing intervention effects on citywide taxicab driver homicide rates, U.S., 1996-2010

	Model 1[a]		Model 2[b]		Model 3[c]	
Variables	**Unadjusted**	**Adjusted**	**Unadjusted**	**Adjusted**	**Unadjusted**	**Adjusted**
Cameras installed	0.18 (0.08, 0.43)	0.14 (0.06, 0.29)	0.21 (0.09,0.52)	0.27 (0.12, 0.61)	—	—
Partitions installed	—	—	—	—	1.01 (0.64, 1.59)	1.15 (0.80, 1.64)
Year[d]	—	1.04 (0.97, 1.11)	—	0.96 (0.90, 1.07)	—	0.92 (0.89, 0.95)
City homicide rate[e]	—	1.05 (0.96, 1.16)	—	1.04 (1.02, 1.06)	—	1.05 (1.03, 1.08)

Note: Values are rate ratio (95% CI).

[a] Testing Hypothesis 1a, difference in taxicab driver homicide rates post-installation versus pre-installation of cameras

[b] Testing Hypothesis 1b, difference in taxicab driver homicide rates in camera cities compared to control cities

[c] Testing Hypothesis 2, difference in taxicab driver homicide rates in partition cities compared to control cities

[d] The rate ratio represents an associated increase in taxicab driver homicide rate for every increase of 1 year.

[e] The rate ratio represents an associated increase in taxicab driver homicide rate for every 1-unit increase in city homicide rate.

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