Supplementary Online Content

This supplementary material has been provided by the authors to give readers additional information about their work.

eAppendix 1. Linking Methods

Linking Handgun Purchasers to Determine Criminal History, Time at Risk, and Community of Residence

Purpose of Linkage Work & Overview

We conducted record linkage to determine subjects' criminal history, time at risk for outcome events, and community of residence. This involved linking our cohort of handgun purchasers to criminal history records (RAP sheets), mortality records, California voter registration records, and to other public records available from LexisNexis Public Records. The criminal history records were used to determine exposure and outcome events. Mortality, voter registration, and LexisNexis records were used to determine if subjects died or moved out of state during the follow-up period and to identify their community of residence over time. Linkage was done using Link Plus (version 2.0), software for probabilistic record linkage developed by the Centers for Disease Control and Prevention and R (version 3.2.3), a statistical programming package. Linkage to the LexisNexis database was conducted by LexisNexis.

Data Sources

Linking variables for the cohort of firearm purchasers were obtained from the Dealers Record of Sale (DROS) database. These included first name, middle name, last name, date of birth, California driver's license number, sex, city, and zip code. RAP sheets were linked to cohort members using first name, middle name, last name, date of birth, and California driver's license number. Sex, city, zip code, and county were used to verify matches. We linked cohort members to each year of the California Death Statistical Master File data from 2001-2015 using first name,

middle name, last name, and date of birth. To link to California voter registration data in 2002 and 2014, we used first name, middle name, last name, date of birth, city, zip code, and sex. Voter ID numbers were then used to follow people forward from 2002 and backward from 2014 to identify purchaser locations during interim time points. Voter ID numbers are county-specific and subject to change if someone moves out of county. If a period of 3 years or more for an individual remained unaccounted for after linking, we queried LexisNexis Public Records. LexisNexis Public Records includes over 10,000 sources such as motor vehicle registrations and personal property records.

Deterministic Matching

An initial round of deterministic matching was done to link DROS to the criminal history RAP sheets. RAP sheets may include various versions of names and aliases along with multiple dates of birth and California driver's license numbers. To address the many multiple and possibly erroneous inputs, we matched on all possible permutations of name, date of birth, and driver's license. This would be computationally restrictive for probabilistic matching, so "easy" matches were first removed through deterministic matching. Deterministic matching was done using name, date of birth, and California driver's license number. Typos were present in both data sources, so fuzzy matching using Levenshtein distance was used to determine approximate matches.

Probabilistic Matching

Link Plus uses the Fellegi-Sunter model to score matches. It uses approximate matching techniques to allow for partial matches, misspellings, hyphenations, typographical errors, names

that sound similar, and nicknames. Link Plus additionally accounts for the uniqueness of a name using name frequencies from the 1990 Census. The weight of select variables in linking was adjusted manually by changing variables' m-probabilities (the probability that a matching variable agrees given that the comparison pair is a match). For example, date of birth was given a higher m-probability than the default (0.98 vs 0.96) to reduce the number of high-scoring matches resulting from exact match of first and last names but clearly non-matching birthdays.

Manual Review

Reviewers identified Link Plus scores in the data at or above which all linkages had a high probability of being correct (upper threshold for manual review) and at or below which all linkages had a high probability of being incorrect (lower threshold). Thresholds varied by data source and year. Linkages with inter-threshold scores were reviewed manually to confirm or reject linkages suggested by Link Plus using matching rules developed by the research team for use with these data. For each data source, multiple reviewers reviewed the same set of data (for the Death Statistical Master Files, two reviewers reviewed two years of linkages and achieved 97.9% correspondence. For the voter registration data, three reviewers went through an iterative process of reviewing 100 linkages, reconciling differences, and reviewing another 100 linkages until all three achieved >95% correspondence). The reviewers then split the remaining data for independent review. Special cases were brought to the broader research team for discussion.

eAppendix 2. Socioeconomic Index

The socioeconomic index captured variation in the percentages of families in poverty, of adults unemployed, of adults with a high school diploma, of adults with a college diploma, and median income at the census tract level in a principal component analysis of the rank transformed data. The index appeared highly reliable (Cronbach's alpha=0.94, with 80% of the variance explained by the first principal component in 2001, 2005, and 2010 data).

eFigure 1. Graphs of Schoenfeld Residuals for Each Exposure Combination and Each Outcome

A. Arrest for Crime Index–listed violent crimes
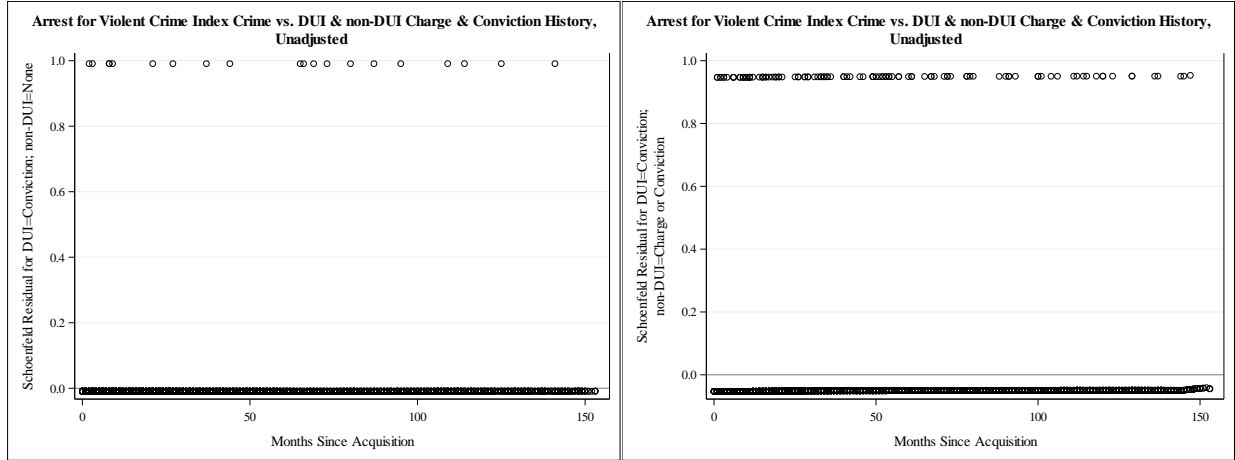
B. Arrest for firearm-related violent crime

C. Arrest for any violent crime
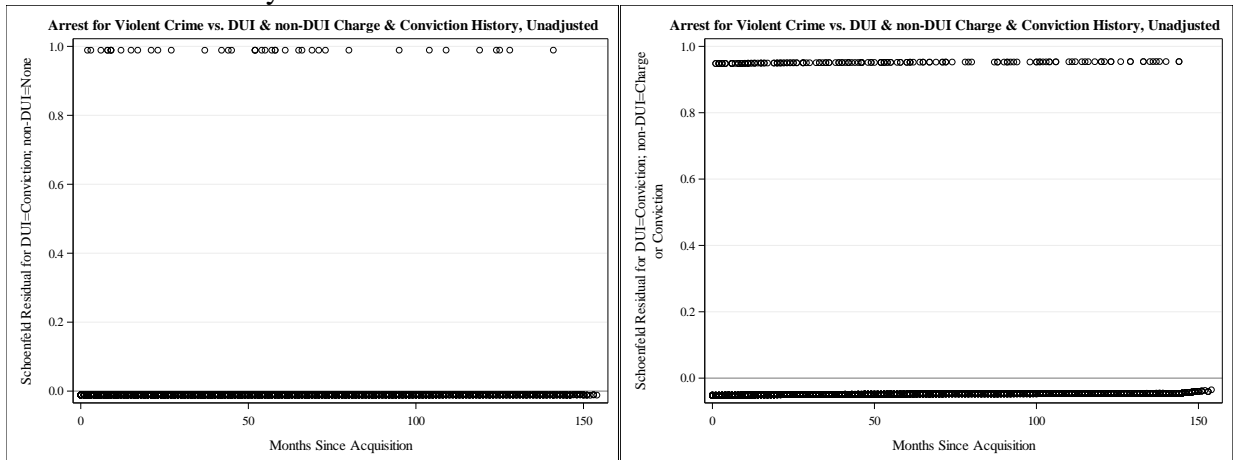
eFigure 2. Flow Chart for Analytic Sample

Initial Dealer Record of Sale (DROS) data.

110,783 unique handgun purchasers in 2001

Initial N = 110,783

↓

Remove California Department of Justice purchasers and records with missing identifiers.

2 (0.002%) California Department of Justice purchasers

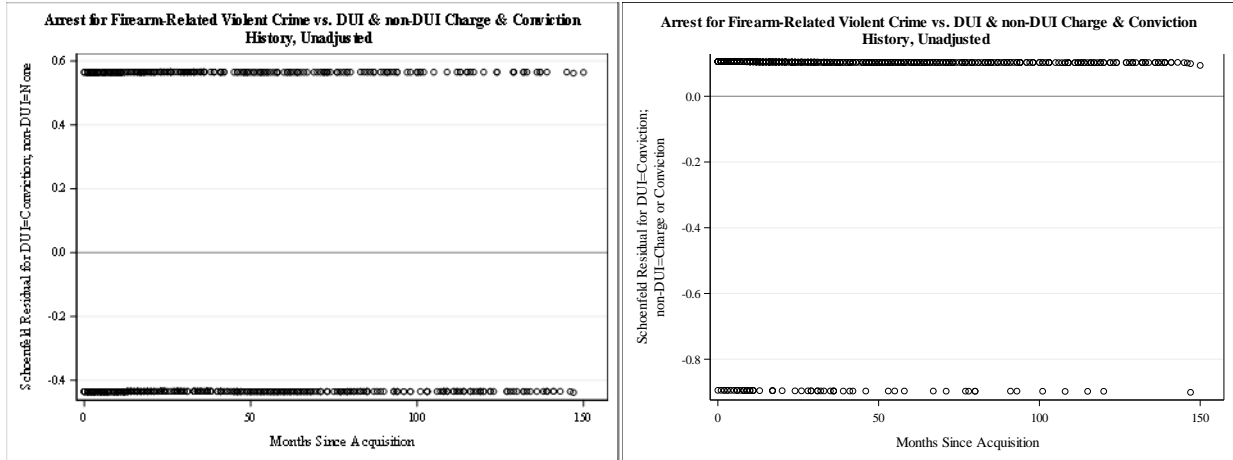42 (0.04%) purchasers missing identifiers

Remaining N = 110,739

↓

Age exclusions.

30,802 (27.8%) purchasers over 50

10 (0.009%) purchasers under 21

Remaining N = 79,927

↓

Unknown criminal history.

249 (0.22%) possible criminal history in missing paper records

Remaining N = 79,678

↓

Invalid follow up.

3 (0.003%) no follow-up information

133 (0.12%) left California before picking up handgun

Remaining N = 79,542

↓

Missing demographic or census tract information.

29 (0.03%) purchasers missing race/ethnicity

635 (0.57%) missing 2001, 2005, and 2010 census tract information

Final N = 78,878

eFigure 3. Purchaser Locations [A] and Purchaser Density per 1000 by Census Tract [B] in 2001
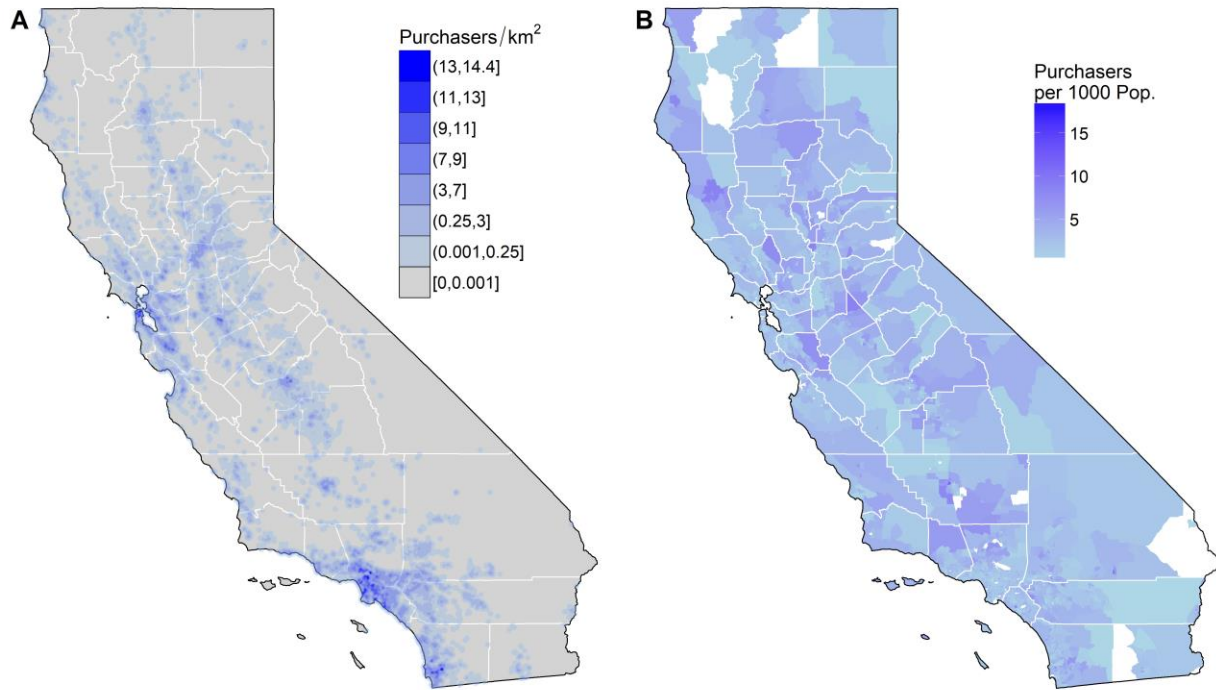
Caption: [B] data for census tracts with population <200 are suppressed.

eTable 1. Comparison of Eligible Study Population and Analytic Sample Across a Range of

Variables

	Eligible Study Population	Sample Included in Adjusted Models[1]
Total population	79,678	78,878
Age (median)	34	34
Male (%)	91.0	91.0
Race/ethnicity		
American Indian (%)	0.6	0.6
Asian (%)	8.0	8.1
Black (%)	5.4	5.4
Latino (%)	15.3	15.3
Other (%)	1.8	1.8
White (%)	68.9	68.8
First-time buyer (%)	53.0	52.7
Prior Arrests or convictions (%)	16.7	16.7
Prior DUI convictions		
1 (%)	1.6	1.6
2 (%)	0.2	0.2
3+ (%)	0.1	0.1

[1]Sample excludes 29 with missing race/ethnicity, 635 with no census tract information during the entire follow-up period, 136 with no follow-up information.

eTable 2. Absolute Differences in Probability of Arrest at 5 and 12 Years Associated With DUI

Conviction at Purchase

	Arrest for Crime Index–Listed Violent Crimes HR (95% CI)	Arrest for Firearm-Related Violent Crimes HR (95% CI)	Arrest for Any Violent Crimes HR (95% CI)
5 Years	0.04 (0.03, 0.05)	0.02 (0.01, 0.03)	0.07 (0.06, 0.09)
12 years	0.07 (0.05, 0.08)	0.02 (0.01, 0.03)	0.11 (0.09, 0.13)

Absolute difference in probability of failure (i.e. first arrest for identified offense) with 95% CI at 5 years and 12 years between those with and without a DUI conviction at purchase, estimated using Kaplan-Meier analysis.

eTable 3. Hazard Ratios for Arrest for Crime Index–Listed Violent Crimes Among First-time

and Repeat Purchasers

	First-Time Purchaser HR (95% CI)	Repeat Purchaser HR (95% CI)
DUI Convictions[1]		
Among those with no other criminal history	3.3 (2.0, 5.4)	1.5 (0.5, 3.9)
Among those with other criminal history	1.5 (1.1, 1.9)	1.2 (0.9, 1.7)
Alcohol-Related Convictions[2]		
Among those with no other criminal history	3.0 (1.8, 5.0)	1.4 (0.5, 3.8)
Among those with other criminal history	1.5 (1.2, 1.9)	1.2 (0.9, 1.7)

HR=Hazard Ratio.

[1] The referent group is no DUI arrests or convictions.

[2] The referent group is no alcohol-related arrests or convictions.

Those arrested but not convicted for the offense of interest (DUI or alcohol-related) were included in each model (results not shown).

Note: DUI criminal history interaction p-values: DUI*non-DUI p<0.0001, DUI*prior purchase p=0.20, non-DUI*prior purchase p=0.066, DUI*non-DUI*prior purchase p=0.46;

Alcohol-related criminal history interaction p-values: alcohol*non-alcohol p=0.0008, alcohol*prior purchase p=0.28, non-alcohol*prior purchase p=0.50, alcohol*non-alcohol*prior purchase p=0.49

Results are adjusted for sex; age; race/ethnicity; number of handguns purchased from 1985 until the index purchase; time elapsed between the most recent DUI and non-DUI related arrest events and the index purchase; census tract population size, population density, proportion of persons age 20-44 who were age 20-24, percentage male, percentage Latino, percentage black, alcohol outlet densities, and socioeconomic status index; county population, violent and property crime rates, and firearm suicides as a proportion of total suicides.

eTable 4. Hazard Ratios for Arrest for Crime Index–Listed Violent Crime by Number of DUI

Convictions Prior to Index Purchase in 2001

	Hazard Ratio (95% CI)
Among those with no other criminal history	
1 DUI Convictions	2.8 (1.8, 4.4)
2+ DUIs Convictions	1.3 (0.2, 9.5)
Among those with other criminal history	
1 DUI Convictions	1.3 (1.0, 1.6)
2+ DUIs Convictions	1.6 (1.1, 2.5)

The referent group is no DUI arrests or convictions. Those arrested but not convicted for DUI were included in the model (results not shown).
Note: 2+ DUI convictions vs. 1 DUI conviction: p=0.48 if no other criminal history, p=0.33 if non-DUI criminal history
Results are adjusted for sex; age; race/ethnicity; number of handguns purchased from 1985 until the index purchase; time elapsed between the most recent DUI and non-DUI related arrest events and the index purchase; census tract population size, population density, proportion of persons age 20-44 who were age 20-24, percentage male, percentage Latino, percentage black, alcohol outlet densities, and socioeconomic status index; county population, violent and property crime rates, and firearm suicides as a proportion of total suicides.

eTable 5. Risk of Arrest or Conviction Associated With DUI and Alcohol-Related Arrests or Convictions

	Arrest for Crime Index–Listed Violent Crimes HR (95% CI)	Arrest for Firearm-Related Violent Crimes HR (95% CI)	Arrest for Any Violent Crimes HR (95% CI)	Conviction for Crime Index–Listed Violent Crimes HR (95% CI)	Conviction for Firearm-Related Violent Crimes HR (95% CI)	Conviction for Any Violent Crimes HR (95% CI)
DUI Convictions						
Among those with no other criminal history	2.6 (1.7, 4.1)	2.8 (1.3, 6.4)	3.3 (2.4, 4.5)	1.9 (0.7, 5.0)	3.8 (1.2, 11.9)	2.5 (1.5, 4.2)
Among those with other criminal history	1.4 (1.1, 1.7)	1.6 (1.1, 2.4)	1.3 (1.1, 1.5)	1.4 (1.0, 2.1)	1.6 (0.9, 2.9)	1.4 (1.2, 1.8)
Alcohol-Related Convictions						
Among those with no other criminal history	2.4 (1.6, 3.8)	2.6 (1.2, 5.9)	3.1 (2.2, 4.2)	1.7 (0.6, 4.7)	3.5 (1.1, 11.1)	2.3 (1.4, 3.9)
Among those with other criminal history	1.4 (1.1, 1.7)	1.6 (1.1, 2.3)	1.3 (1.1, 1.5)	1.4 (1.0, 2.1)	1.6 (0.9, 2.8)	1.4 (1.2, 1.8)
DUI Arrests without Convictions						
Among those with no other criminal history	3.9 (2.4, 6.5)	3.8 (1.4, 10.1)	3.4 (2.2, 5.1)	3.3 (1.2, 9.0)	2.5 (0.3, 17.9)	3.3 (1.7, 6.1)
Among those with other criminal history	1.1 (0.9, 1.5)	1.2 (0.7, 2.0)	1.1 (0.9, 1.4)	1.3 (0.8, 2.1)	0.7 (0.2, 1.8)	1.3 (1.0, 1.7)

Alcohol-Related Arrests without Convictions						
Among those with no other criminal history	3.6 (2.2, 5.8)	3.3 (1.2, 8.8)	3.1 (2.1, 4.7)	3.5 (1.4, 8.6)	2.2 (0.3, 15.5)	3.1 (1.7, 5.6)
Among those with other criminal history	1.3 (1.0, 1.7)	1.2 (0.7, 2.0)	1.2 (1.0, 1.5)	1.5 (1.0, 2.4)	0.6 (0.2, 1.8)	1.4 (1.1, 1.9)

HR=Hazard Ratio.

Results are adjusted for sex; age; race/ethnicity; number of handguns purchased from 1985 until the index purchase; time elapsed between the most recent DUI and non-DUI related arrest events and the index purchase; census tract population size, population density, proportion of persons age 20-44 who were age 20-24, percentage male, percentage Latino, percentage black, alcohol outlet densities, and socioeconomic status index; county population, violent and property crime rates, and firearm suicides as a proportion of total suicides.

eTable 6. Risk of Arrest Associated With DUI Conviction and Alcohol-Related Arrests or

Convictions, Including 249 Individuals With Missing Criminal History Data

	Arrest for Crime Index–Listed Violent Crimes HR (95% CI)	Arrest for Firearm-Related Violent Crimes HR (95% CI)	Arrest for Any Violent Crimes HR (95% CI)
DUI Convictions			
Among those with no other criminal history	2.6 (1.7, 4.1)	2.9 (1.3, 6.4)	3.3 (2.4, 4.5)
Among those with other criminal history	1.4 (1.1, 1.7)	1.6 (1.1, 2.4)	1.3 (1.1, 1.5)
Alcohol-Related Convictions			
Among those with no other criminal history	2.5 (1.6, 3.8)	2.7 (1.2, 6.0)	3.1 (2.3, 4.2)
Among those with other criminal history	1.4 (1.1, 1.7)	1.6 (1.1, 2.3)	1.3 (1.1, 1.5)
DUI Arrests without Convictions			
Among those with no other criminal history	4.0 (2.4, 6.5)	3.8 (1.4, 10.1)	3.4 (2.2, 5.2)
Among those with other criminal history	1.1 (0.9, 1.5)	1.2 (0.7, 2.0)	1.1 (0.9, 1.4)
Alcohol-Related Arrests without Convictions			
Among those with no other criminal history	3.6 (2.2, 5.8)	3.3 (1.2, 8.9)	3.2 (2.1, 4.7)
Among those with other criminal history	1.3 (1.0, 1.7)	1.2 (0.7, 2.0)	1.2 (1.0, 1.5)

HR=Hazard Ratio.
There were 249 cohort members with no recent criminal history for whom we could not determine the existence of early (pre-1976) criminal events that may have been stored on CA DOJ's paper files. These subjects were included as having no criminal history in this sensitivity analysis.
Results are adjusted for sex; age; race/ethnicity; number of handguns purchased from 1985 until the index purchase; time elapsed between the most recent DUI and non-DUI related arrest events and the index purchase; census tract population size, population density, proportion of persons age 20-44 who were age 20-24, percentage male, percentage Latino, percentage black, alcohol outlet densities, and socioeconomic status index; county population, violent and property crime rates, and firearm suicides as a proportion of total suicides.

eTable 7. Risk of Arrest Associated With DUI Conviction and Alcohol-Related Arrests or Convictions, Excluding Purged and Procedural Crimes

	Arrest for Crime Index–Listed Violent Crimes HR (95% CI)	Arrest for Firearm-Related Violent Crimes HR (95% CI)	Arrest for Any Violent Crimes HR (95% CI)
DUI Convictions			
Among those with no other criminal history	2.6 (1.6, 4.0)	2.8 (1.2, 6.2)	3.2 (2.4, 4.4)
Among those with other criminal history	1.4 (1.1, 1.7)	1.7 (1.1, 2.5)	1.3 (1.1, 1.6)
Alcohol-Related Convictions			
Among those with no other criminal history	2.4 (1.5, 3.7)	2.6 (1.1, 5.8)	3.1 (2.3, 4.2)
Among those with other criminal history	1.4 (1.2, 1.7)	1.6 (1.1, 2.3)	1.3 (1.1, 1.6)
DUI Arrests without Convictions			
Among those with no other criminal history	3.8 (2.3, 6.2)	3.6 (1.3, 9.6)	3.2 (2.1, 4.9)
Among those with other criminal history	1.2 (0.9, 1.5)	1.2 (0.7, 2.1)	1.1 (0.9, 1.4)
Alcohol-Related Arrests without Convictions			
Among those with no other criminal history	3.5 (2.1, 5.6)	3.2 (1.2, 8.5)	3.0 (2.0, 4.5)
Among those with other criminal history	1.3 (1.0, 1.7)	1.2 (0.7, 2.0)	1.2 (1.0, 1.5)

HR=Hazard Ratio.
Procedural offenses included AWOL, contempt of court, failure to appear, probation violations, sentence enhancements and specific warrant arrests. Purged offenses are those drug and alcohol offenses that the Department of Justice deemed should be removed from the criminal record, such as disorderly conduct: alcohol and possession of marijuana.
Results are adjusted for sex; age; race/ethnicity; number of handguns purchased from 1985 until the index purchase; time elapsed between the most recent DUI and non-DUI related arrest events and the index purchase; census tract population size, population density, proportion of persons age 20-44 who were age 20-24, percentage male, percentage Latino, percentage black, alcohol outlet densities, and socioeconomic status index; county population, violent and property crime rates, and firearm suicides as a proportion of total suicides.

eTable 8. Risk of Subsequent Arrest Associated With DUI Conviction Prior to Handgun

Purchase: Partially Adjusted

	Crime Index–Listed Violent Crimes HR (95% CI)	Firearm-related Violent Crime HR (95% CI)	Any Violent Crime HR (95% CI)
DUI Alone Purchasers with only DUI convictions[1] vs. purchasers with no criminal history[2]	2.6 (1.7, 4.1)	2.8 (1.3, 6.4)	3.3 (2.4, 4.5)
Other Crime Alone Purchasers with only non-DUI arrests or convictions[3] vs. purchasers with no criminal history[2]	4.3 (3.9, 4.8)	3.7 (3.1, 4.6)	4.5 (4.2, 4.9)
DUI and Other Crime Combined Purchasers with both DUI convictions and non-DUI arrests or convictions[4] vs. purchasers with no criminal history[2]	5.9 (4.9, 7.2)	6.1 (4.2, 8.8)	5.9 (5.0, 6.9)
DUI If Other Crime Purchasers with both DUI convictions and non-DUI arrests or convictions[4] vs. purchasers with only non-DUI arrests or convictions[3]	1.4 (1.1, 1.7)	1.6 (1.1, 2.4)	1.3 (1.1, 1.5)

HR=Hazard Ratio.

[1]Only DUI convictions and no other arrests or convictions. [2]No arrests or convictions of any kind. [3]Arrests or convictions for non-DUI crimes and no arrests or convictions for DUI. [4]DUI convictions and arrests or convictions for non-DUI crimes.

People with arrests but no convictions for driving under the influence were identified separately in the statistical model. Results are not shown.

Non-DUI crimes include other alcohol-related crimes.

Results are adjusted for sex; age; race/ethnicity; number of handguns purchased from 1985 until the index purchase; time elapsed between the most recent DUI and non-DUI related arrest events and the index purchase; census tract population density, alcohol outlet densities, and socioeconomic status index; county population, and violent crime rates.