STATE OF CALIFORNIA
DEPARTMENT OF MOTOR VEHICLES

ESTIMATION OF FATAL CRASH RATES FOR SUSPENDED/REVOKED AND UNLICENSED DRIVERS IN CALIFORNIA

September 2012

Author: Sukhvir S. Brar
Research and Development Branch
Licensing Operations Division

RSS-12-238

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
September 2012	Final Report	

4. TITLE AND SUBTITLE

Estimation of Fatal Crash Rates for Suspended/Revoked and Unlicensed Drivers in California

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Sukhvir S. Brar

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

California Department of Motor Vehicles
Research and Development Branch
P.O. Box 932382
Sacramento, CA 94232-3820

8. PERFORMING ORGANIZATION REPORT NUMBER

CAL-DMV-RSS-12-238

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This study used a quasi-induced exposure (QIE) analysis technique to estimate annual fatal crash involvement rates for S/R, unlicensed, and validly licensed drivers in California from 1987 through 2009 using fatal crash data obtained from National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS) and California Department of Highway Patrol's Statewide Integrated Traffic Records System (SWITRS). The annual fatal crash involvement ratios range from 0.81 to 0.91 for validly licensed drivers, 1.44 to 4.29 for S/R drivers, and 1.60 to 3.50 for unlicensed drivers, respectively, over the 23-year time period studied. The annual at-fault overinvolvement rates for S/R and unlicensed drivers relative to validly licensed drivers range from 1.57 to 4.93 for the S/R group and from 1.84 to 4.10 for the unlicensed group. Although the annual rates fluctuate, S/R and unlicensed drivers were overinvolved as at-fault drivers in fatal crashes every year relative to validly licensed drivers. The fatal crash involvement ratios obtained for all years combined (1987 through 2009) are 0.86 for validly licensed drivers, 2.23 for S/R drivers, and 2.34 for unlicensed drivers. The at-fault overinvolvement rates for the S/R and unlicensed groups, relative to the validly licensed group, are 2.60 and 2.73, respectively, for this 23-year period. The study results provide strong evidence that S/R and unlicensed drivers are much more hazardous on the road than are validly licensed drivers. Compared to licensed drivers, those who drive without a valid license are nearly three times more likely to cause a fatal crash relative to their exposure. The study findings strongly justify the use of countermeasures, including vehicle impoundment, to control S/R and unlicensed drivers and to reduce crashes caused by these drivers.

15. SUBJECT TERMS

Quasi-induced exposure, Suspended/revoked drivers, Unlicensed drivers, Fatal crash rates

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Douglas P. Rickard
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPONE NUMBER (*Include area code*)
Unclassified	Unclassified	Unclassified	None	24	916-657-5768

PREFACE

This report is issued as a publication of the Department of Motor Vehicles Research and Development Branch rather than an official report of the State of California. The findings, opinions, and conclusions presented are those of the author and may not represent the views and policies of the State of California.

ACKNOWLEDGEMENTS

This project was conducted under the general direction of David DeYoung, Research Chief, and the supervision of Robert Hagge, Research Manager II. Scott Masten, Research Manager II, provided consultation on the collection and processing of fatal crash data. Douglas Rickard, Associate Governmental Program Analyst, helped type and proofread the report.

EXECUTIVE SUMMARY

Introduction

- Suspended/revoked (S/R) and unlicensed drivers continue to be part of California's driving population.

- The traffic safety risks that S/R and unlicensed drivers pose to other road users is of ongoing interest to the traffic safety community and therefore should be periodically assessed.

Methods

- This study used a quasi-induced exposure (QIE) analysis technique to estimate annual fatal crash involvement rates for S/R, unlicensed, and validly licensed drivers in California from 1987 through 2009.

- The crash involvement ratio for each group relative to its driving exposure was calculated by dividing the group's percentage of at-fault drivers by its percentage of innocent drivers in two-vehicle fatal crashes.

- The overinvolvement of S/R and unlicensed drivers as the culpable party in fatal crashes was determined by dividing the crash involvement ratios for these two groups by the crash involvement ratio for the validly licensed group.

Results

- The annual fatal crash involvement ratios range from 0.81 to 0.91 for validly licensed drivers, 1.44 to 4.29 for S/R drivers, and 1.60 to 3.50 for unlicensed drivers, respectively, over the 23-year time period studied. The fact that the rates for S/R and unlicensed drivers exceeded 1.0 in every year indicates that these drivers were consistently more likely to be at-fault than to be innocent in their crashes.

- The annual at-fault overinvolvement rates for S/R and unlicensed drivers relative to validly licensed drivers range from 1.57 to 4.93 for the S/R group and from 1.84 to 4.10 for the

unlicensed group. Although the annual rates fluctuate, these two groups were overinvolved as at-fault drivers in fatal crashes every year relative to validly licensed drivers.

- The at-fault overinvolvement rate for unlicensed drivers did not change systematically following enactment on January 1, 1994 of California Vehicle Code Section 12801.5, which prevents issuance of a driver license to individuals who cannot provide the required documentation to show that their presence in California is authorized under federal law.

- The fatal crash involvement ratios obtained for all years combined (1987 through 2009) are 0.86 for validly licensed drivers, 2.23 for S/R drivers, and 2.34 for unlicensed drivers. The at-fault overinvolvement rates for the S/R and unlicensed groups, relative to the validly licensed group, are 2.60 and 2.73, respectively, for this 23-year period.

Conclusions

- The study results provide strong evidence that S/R and unlicensed drivers are much more hazardous on the road than are validly licensed drivers. Compared to licensed drivers, those who drive without a valid license are nearly three times more likely to cause a fatal crash relative to their exposure.

- Unlicensed drivers tend to be more hazardous than S/R drivers.

- The finding that the annual fatal crash overinvolvement rate for unlicensed drivers did not change following enactment of Vehicle Code Section 12801.5 suggests that unlicensed drivers who are ineligible to become licensed under this law are just as hazardous as drivers who are unlicensed for other reasons. If they were truly safer drivers, it would be expected that their increasing representation among unlicensed drivers after the law took effect would be associated with a concurrent reduction in the fatal crash overinvolvement rate for unlicensed drivers as an overall group, which isn't supported by the study findings.

Recommendations

- The study findings strongly justify the use of countermeasures, including vehicle impoundment, to control S/R and unlicensed drivers and to reduce crashes caused by these drivers.

- Future crash risk studies conducted on S/R and unlicensed drivers should, if possible, include single- and multi-vehicle crashes, non-fatal crashes, and crashes involving additional types of vehicles.

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF CONTENTS (continued)

LIST OF TABLES (continued)

LIST OF FIGURES

INTRODUCTION

Death from motor vehicle crashes continues to be a major health problem in the United States. Although the number of deaths from motor vehicle crashes has continued to decrease, the overall figures are still alarming. The US Department of Transportation National Highway Traffic Safety Administration (U.S. Department of Transportation, 2009) reported that, while total traffic fatalities decreased by 9.7% from 2008 to 2009, there were still 33,808 deaths attributed to motor vehicle traffic crashes nationally in 2009. The same report showed that total traffic fatalities in California mirrored the national trend, with a 10% statewide reduction from 2008 to 2009. Although traffic fatalities have been trending down, the number of drivers involved in fatal crashes who did not have a valid license at the time of the crash increased by 17% nationally and 49% in California from 1998 through 2007 (U.S. Department of Transportation, 2009a). The same source reported that the percentage of fatal-crash involved drivers who did not have a valid license increased by 27% nationally (from 11% in 1998 to 14% in 2007) over this 10-year time period. A DMV analysis of all Fatality Analysis Reporting System (FARS) crashes in California found a 23% increase in the rate of drivers in these crashes without a valid license (from 14.5% in 1998 to 17.8% in 2007). These findings indicate a need to better understand individuals who drive without a valid license, and to use effective countermeasures to control these drivers and reduce the fatal crashes that they cause.

Suspended/revoked and unlicensed drivers constitute a significant part of the California driving population and are known to pose an elevated traffic safety risk to other road users. One out of every five fatal crashes in the United States involves an unlicensed or invalidly licensed driver (AAA Foundation for Traffic Safety, 2011; Griffin & DeLaZerda, 2000). When compared to validly licensed drivers, S/R and unlicensed drivers are much more likely to have caused fatal crashes in which they are involved (DeYoung, Peck, & Helander, 1997). In addition, crashes caused by unlicensed drivers tend to be more severe and are more likely to involve a fatality than those caused by licensed drivers (Watson, 2004). The number of such cases has since increased along with increases in the California driver population.

The elevated risk that S/R and unlicensed drivers pose to other road users has been of ongoing interest and concern to the traffic safety community. Since the composition of the S/R and unlicensed driver populations, and their risks, can change over time, it is important to periodically assess their risks. This study addresses this need by analyzing fatal crashes in California from 1987 through 2009, specifically by comparing the at-fault crash risks for the S/R

and unlicensed driver groups to that for validly licensed drivers, both annually and over all years combined.

Suspended/Revoked Drivers

A DMV study conducted in 2002 found that 1.9 million individuals were under a license suspension or revocation action at any given point in time during that year (Roberts, 2002). An individual's driving privilege can be suspended/revoked for a variety of reasons, including, but not limited to, being convicted of a serious traffic violation such as driving under the influence of alcohol and/or drugs or reckless driving, accumulating too many negligent-operator points on the driving record, inadequate driving skills, and having a physical or mental condition that compromises their ability to drive safely.[1] A driver license can also be withdrawn for reasons having nothing to do with driving, such as failure to pay child support and conviction for graffiti or vandalism (Gebers & DeYoung, 2002).

License suspension/revocation has been used for decades to control problem drivers. Departmental studies have consistently found that withdrawal of the driving privilege reduces subsequent traffic violations and crashes among treated drivers. This safety outcome is achieved even though most S/R drivers continue to drive during the period of suspension or revocation (U.S. Department of Transportation, 2008). The reason is that, even though the license suspension/revocation order is being violated, S/R drivers limit their exposure and drive more carefully to avoid detection (Clark & Bobevski, 2008; Hagen, McConnell, & Williams, 1980; Ross & Gonzales, 1988). Although less is known about the detection-avoidance driving behaviors of unlicensed drivers, it is commonly accepted that they also tend to limit their driving exposure and drive more carefully to reduce the likelihood of detection.

Unlicensed Drivers

The number and characteristics of unlicensed drivers in California are less certain because these drivers do not come to the attention of the DMV until they are involved in a crash or convicted of a traffic violation and consequently reported to the DMV. In addition, those who are reported to the DMV are difficult to monitor due to inherent difficulties in matching each reported

[1]License suspension temporarily withdraws the driving privilege, while license revocation terminates it with the possibility of reinstatement at the end of the revocation period.

unlicensed driver, using the name and address they provided, to previous records that may have been created for that individual in the DMV's Driver Record Master (DRM) electronic database.

While little is known about unlicensed drivers, it is likely that the percentage of drivers in this group who are ineligible for a license due to their legal-presence status increased following enactment of California Senate Bill SB 976 (California Vehicle Code Section [CVC] 12801.5) on January 1, 1994. This law requires driver license applicants to provide a valid Social Security Number and documents proving that their presence in California is authorized under federal law before they can be issued a driver license. The law, as enacted, also applied to previously licensed drivers upon license renewal.

Efforts to Control Suspended/Revoked and Unlicensed Drivers

Countermeasures applied in California to control S/R and unlicensed drivers and reduce crashes caused by these drivers include the following actions that may be taken against those caught driving during the period of license withdrawal or while unlicensed: (1) 30-day impoundment of the vehicle they were driving, (2) monetary fines, (3) jail time, (4) extending the period of probation/suspension, and (5) accrual of negligent-operator points on the driver record that may trigger additional interventions. Such countermeasures are intended to incapacitate the driver for a relatively brief period, to deter those apprehended from reoffending (specific deterrence), and to prevent all disqualified drivers from driving in the first place (general deterrence). Through these mechanisms, driving exposure should be reduced, resulting in a reduction in crashes.

One treatment option that stands out as being highly effective is vehicle impoundment as authorized in CVC Section 14602.6 (enacted in 1995). A prior DMV research study (DeYoung, 1999) found that, after adjusting for other crash-related variables, S/R and unlicensed drivers whose vehicles were impounded had significantly fewer crashes, on average, than did such drivers whose vehicles were not impounded. Unlicensed and S/R drivers who were first offenders and who had their vehicles impounded had 25% fewer subsequent crashes and 18% fewer convictions than did the first offenders in the control group (who did not have their vehicles impounded). Repeat offenders in the impound group had 38% fewer crashes and 23% fewer convictions than did their counterparts in the control group. In addition, an in-depth literature review of studies on the use of vehicle impoundment conducted by Voas & DeYoung (2002), found that this countermeasure and other vehicle-based sanctions yielded substantial traffic safety benefits when applied in various jurisdictions to drivers caught driving without a valid license. Although these findings are somewhat dated, there is no reason to believe that the

efficacy of vehicle impoundment in reducing crashes and traffic convictions among S/R and unlicensed drivers would be any less today under current licensing laws.

Developing Better Risk Estimates for Suspended/Revoked and Unlicensed Drivers

While S/R and unlicensed drivers are known to pose elevated safety risks to other road users, the risks have been difficult to estimate due to the lack of complete and reliable data on the concentration of such drivers on the road, the conditions in which they drive, the number of miles they travel, their driving times and locations, and other exposure variables that influence their risk levels. The lack of good and easily obtainable exposure information often results in exposure not being considered at all when estimating crash risk. When attempts are made to estimate exposure-adjusted crash rates for a group, they usually rely on exposure measures such as number of group members in the overall population, number of licensed drivers in the group, miles driven by drivers in the group, and number of vehicles owned by group members, all of which are limited in scope and often unreliable (Stamatiadis & Deacon, 1997). More recently, risk assessment methods have been used that estimate exposure directly from the crash data. Such methods, commonly referred to as induced exposure techniques, can produce exposure and risk estimates that are more reliable and less biased than what is possible through other means.

The concept of induced exposure and its use in estimating traffic crash risk was introduced in the mid 1960s by Thorpe (1964). Thorpe determined that the likelihood of a non-responsible driver being involved in a crash is proportional to the likelihood of meeting that driver on the road. The quasi-induced exposure (QIE) technique used in the present study is based on a refinement of Thorpe's concept made by Carr (1969). Carr's method calculates the exposure-adjusted crash rate for a given group by dividing the group's proportion of all crash-involved at-fault drivers by the group's proportion of all crash-involved innocent drivers.

The QIE technique assumes that nonresponsible drivers involved in collisions are a statistically random sample of all drivers on the road (Chandraratna & Stamatiadis, 2009). If this assumption is met, then the exposure-adjusted crash risk for a certain type of driver can be determined by comparing how frequently drivers of this type appear among at-fault drivers to how frequently such drivers appear among innocent drivers (Carr, 1969; Lardelli-Claret et al., 2006).

The current study applied the QIE technique to estimate annual exposure-adjusted fatal crash involvement rates for S/R, unlicensed, and validly licensed drivers in California from 1987 through 2009. The methodology used is the same as that used in an earlier DMV study by

DeYoung et al. (1997), with the exception of how crash fault was determined. The earlier study analyzed fatal crashes in California from 1987 through 1992 and found that S/R and unlicensed drivers were, respectively, 3.7 and 4.9 times more likely to be at-fault in fatal crashes than were validly-licensed drivers, relative to their driving exposures. More will be said about this earlier study and how it differed from the current one in the Discussion section of this report.

METHODS

Data Collection and Processing

Data on fatal crashes in California from 1987 through 2009 were gathered from the Fatality Analysis Reporting System (FARS) maintained by the National Highway Traffic Safety Administration (NHTSA), and from the Statewide Integrated Traffic Records System (SWITRS) maintained by the California Highway Patrol (CHP). FARS contains data on crashes that resulted in the death of a vehicle occupant or non-motorist within 30 days of the crash. SWITRS contains data on all police-reported crashes that occurred in California on public roadways. While both of these sources provide data on fatal crashes, it was necessary to access both because neither alone provided all the information needed for the current study. Specifically, only FARS contains information on license status (valid, S/R, or unlicensed), and only SWITRS contains information on which driver the investigating law enforcement officer deemed to have caused the crash. While FARS identifies drivers who were cited for traffic violations preceding the crash, this information was not used to establish culpability because, among other reasons (explained in the Discussion section), at-fault drivers who are killed in the crash are commonly not cited for their violations.

The crash data obtained from FARS and SWITRS were merged so that both license status and fault information would be available for each individual for analysis purposes. The variables used for the merge were crash date (year, month, day), crash time (hour, minute), driver age, driver sex, and vehicle model year. The matching was done at the party (driver) level.

The QIE technique, as applied in this study, required that only certain types of fatal crashes be included in the analyses. Specifically, to be included, a crash had to meet all of the following criteria: (1) involve exactly two vehicles (drivers); (2) have one at-fault driver and one not-at-fault driver; (3) have both drivers identified as validly licensed, S/R, or unlicensed; and (4) involve only passenger cars or pickup trucks as the driven vehicles. For purposes of the above selection, a driver was considered at-fault if they were listed as such in SWITRS, and not at fault otherwise. A crash was excluded from the analysis if neither of the two drivers was listed as being at fault. Since SWITRS does not list more than one driver as being at-fault in any given crash, no crashes had to be eliminated due to both drivers being considered at-fault.

Estimation of Crash Risk

The induced exposure method of estimating crash risk involves calculating the following ratios for each driver group of interest (Cerrelli, 1973).

$$\text{Liability Index} = \frac{\text{\% at-fault drivers in group}}{\text{\% group in driving population}}$$

$$\text{Relative Exposure Index} = \frac{\text{\% not-at-fault drivers in group}}{\text{\% group in driving population}}$$

$$\text{Hazard Index} = \frac{\text{Liability Index}}{\text{Relative Exposure Index}}$$

While the induced exposure method can be used to determine exposure-adjusted crash rates for validly licensed and S/R drivers, it cannot be used as such for unlicensed drivers because the proportion of unlicensed drivers in the driving population is unknown. The QIE technique does not have this limitation because it doesn't correct for group representation in the population (DeYoung et al., 1997). Instead, the QIE method calculates the exposure-adjusted crash rate for a given group by dividing the group's proportion of all crash-involved at-fault drivers by the group's proportion of all crash-involved innocent drivers as shown below.

$$\text{QIE Crash Involvement Ratio} = \frac{\text{\% at-fault drivers in group}}{\text{\% not-at-fault drivers in group}}$$

RESULTS

Data Processing

A total of 86,514 records of driver-involved fatal crashes in California from 1987 through 2009 were identified in the FARS database. Of these crash incidents, 52,717 (61%) involved only one vehicle (driver), 27,483 (32%) involved two vehicles, and 6,314 (7%) involved three or more vehicles. Since the QIE technique used in this study uses only two-vehicle crashes, only the 27,483 crashes of that type were considered further for possible inclusion in the analyses.

Using the FARS data, it was determined that 15,316 (56%) of the identified two-vehicle crashes included at least one vehicle that was not a passenger car or pickup truck. These crashes were excluded from the analyses because they did not meet the inclusion criteria described above. An additional 1,380 (5%) of the two-vehicle crashes were excluded because one or both drivers were not identified as being validly licensed, S/R, or unlicensed. This left 10,787 two-vehicle fatal crashes available for matching to the SWITRS file to obtain information on driver fault status.

Before attempting to merge the FARS and SWITRS datasets, it was determined that eight FARS crash cases had the same values on the matching variables for both involved drivers. Since this prevented the drivers in these crashes from being distinguished as individuals (within the crash case), these crashes were removed from the sample. Eighteen additional FARS crash cases were set aside because matching data were missing for one or both drivers. The remaining 10,761 two-vehicle fatal crashes were available for the QIE analyses, provided each of them could be matched to a unique fatal crash record in the SWITRS database.

The matching process successfully matched 9,532 (89%) FARS records to SWITRS records, with the remaining 1,229 FARS records unmatched. Failure to find a match was primarily due to data on the matching variables (usually age, sex, or vehicle year) being missing in SWITRS for one or both drivers, making a match impossible. Data on the matching variables were rarely missing in FARS because of extensive efforts by FARS to obtain data that were missing on the original hardcopy crash reports that are key-entered into the SWITRS database.

The 9,532 matched crash cases contained both FARS and SWITRS data. Using the SWITRS fault information, it was determined that 197 of these cases had unknown fault information for one or both drivers, and another 565 cases had neither driver listed as being at fault. Removing

these crash cases from the sample left 8,770, or 32% of the original 27,483 two-vehicle fatal crashes, available for use in the QIE analyses.

Table 1 shows the numbers of cases in the original FARS two-vehicle fatal crash sample that were discarded for various reasons in the process of obtaining a final crash sample to use in the QIE analyses. The order of entries in the table parallels the sequence of processing and elimination of cases, beginning with the 27,483 cases identified in FARS and ending with the 8,770 cases with combined FARS and SWITRS data available for analysis.

Table 1

Number (*N*) of Two-Vehicle Fatal Crashes Excluded from the QIE Analyses for Various Reasons

Reason for exclusion	*N*
Original FARS sample	27,483
Excluded due to wrong vehicle type	15,316
Excluded due to wrong license status	1,380
Excluded due to duplicate matching data	8
Excluded due to missing matching data	18
Excluded due to non-match with SWITRS	1,229
Excluded due to unknown fault status	197
Excluded due to neither driver at fault	565
Final QIE sample	8,770

Driver Age by Group

Table 2 and Figure 1 show the distribution of drivers included in the QIE analyses by age group and license status. It is evident that crash-involved S/R and unlicensed drivers tend to be younger than crash-involved validly licensed drivers.

Annual Group Fatal Crash Involvement Ratios

The yearly crash involvement ratios for validly licensed, S/R, and unlicensed drivers from 1987 through 2009 are shown in Table 3 and Figure 2. The group crash involvement ratio is essentially the crash involvement rate for the group, adjusted for the group's exposure. A ratio greater than 1.0 indicates that drivers in the group, as a whole, are overinvolved as at-fault

Table 2
Number (*N*) and Percentage of Drivers in the Study's Sample of Two-Vehicle Fatal Crashes from 1987 through 2009 by Age Group and License Status

Age group	Validly licensed		S/R		Unlicensed	
	N	%	*N*	%	*N*	%
19 or younger	1,521	10.35	104	6.31	297	24.87
20-29	3,798	25.84	770	46.69	587	49.16
30-39	2,772	18.86	428	25.96	190	15.91
40-49	2,232	15.19	208	12.61	64	5.36
50-59	1,521	10.35	72	4.37	26	2.18
60-69	1,125	7.65	33	2.00	18	1.51
70-79	1,018	6.93	19	1.15	6	0.50
80-89	642	4.37	11	0.67	6	0.50
90 or older	68	0.46	4	0.24	0	0.00
Total	14,697	100.00	1,649	100.00	1,194	100.00

Note. Percentages for the unlicensed group do not total to 100.00% due to rounding.

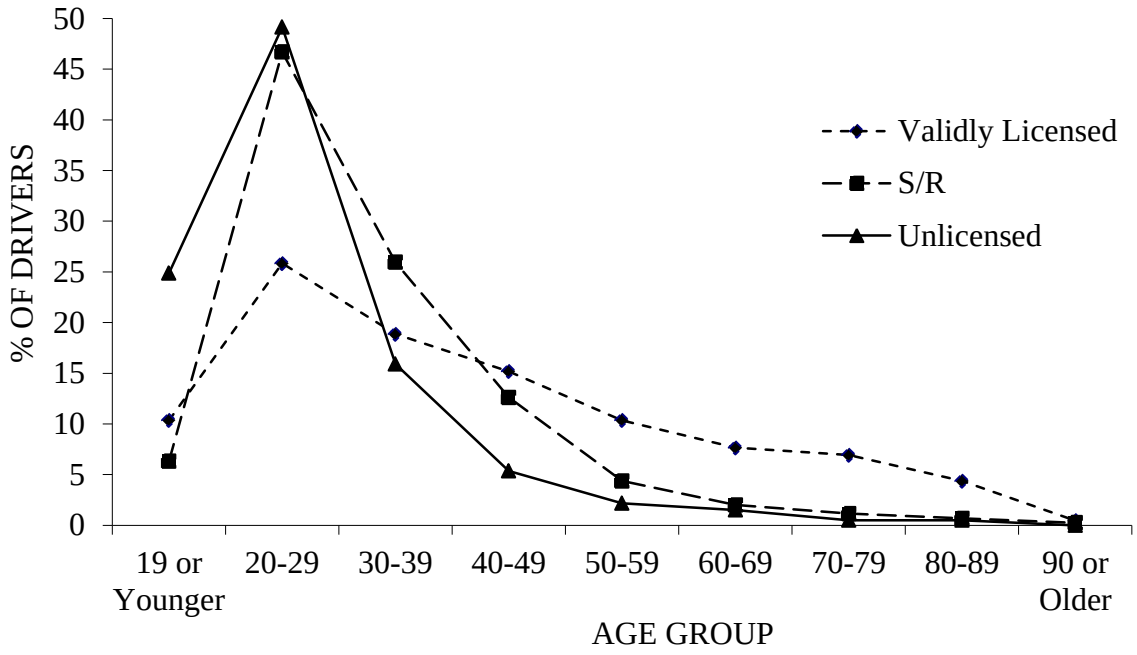

Figure 1. Percentage of drivers in the study's sample of two-vehicle fatal crashes from 1987 through 2009 by age group and license status.

Table 3

Annual Group Fatal Crash Involvement Ratios for Validly Licensed, Suspended/Revoked (S/R), and Unlicensed Drivers from 1987 through 2009

Year	Validly licensed	S/R	Unlicensed
1987	0.87	2.54	2.29
1988	0.91	1.68	1.79
1989	0.82	2.57	3.31
1990	0.82	2.38	2.75
1991	0.84	1.62	3.00
1992	0.81	2.49	2.27
1993	0.84	2.38	1.96
1994	0.86	1.85	1.63
1995	0.86	3.47	2.14
1996	0.91	1.44	2.64
1997	0.85	2.47	3.27
1998	0.85	2.67	3.50
1999	0.88	2.75	2.33
2000	0.90	2.36	2.08
2001	0.87	2.80	3.50
2002	0.83	3.55	3.00
2003	0.87	2.00	2.29
2004	0.84	2.05	2.22
2005	0.87	4.29	1.60
2006	0.86	2.31	2.41
2007	0.87	1.45	2.59
2008	0.91	1.71	1.78
2009	0.89	2.57	2.71

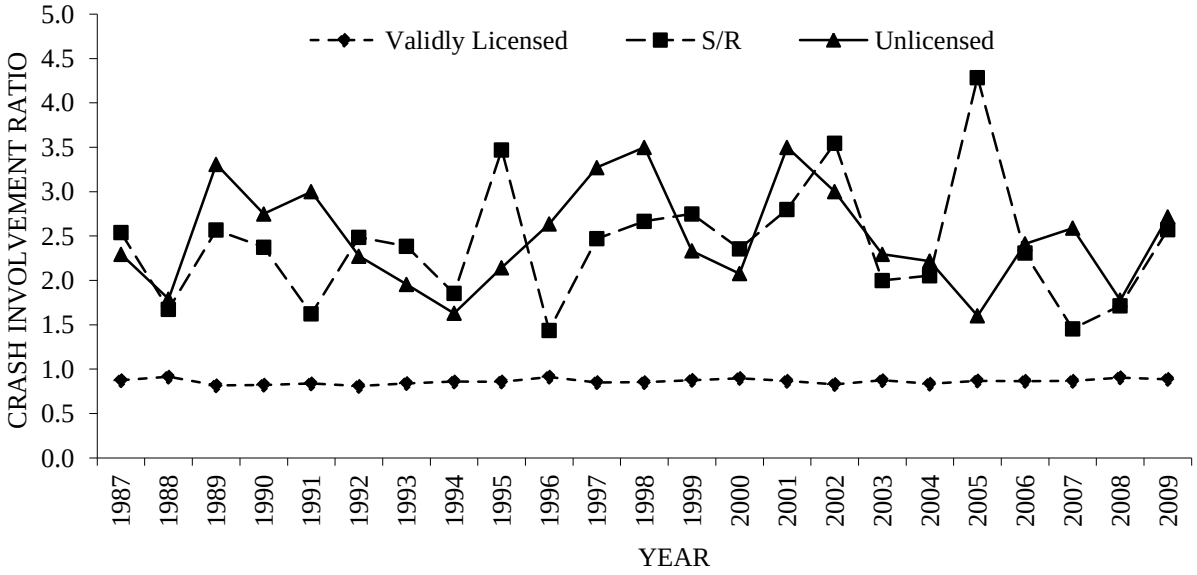

Figure 2. Annual group fatal crash involvement ratios for validly licensed, suspended/revoked (S/R), and unlicensed drivers from 1987 through 2009.

drivers relative to their exposure (as indicated by their percentage representation among innocent drivers). The annual ratios range from 0.81 to 0.91 for validly licensed drivers, 1.44 to 4.29 for S/R drivers, and 1.60 to 3.50 for unlicensed drivers. The wide fluctuation in the ratios for the S/R and unlicensed groups is not surprising, given the relatively small number of fatal crashes involving improperly licensed drivers each year. Importantly, all ratios for these two groups exceed 1.00, indicating that both groups were over-involved as at-fault drivers in fatal crashes every year, relative to their exposure. In addition, the ratios for both groups exceed that for validly licensed drivers in every year analyzed.

Annual Group Fatal Crash Overinvolvement Rates

The annual fatal crash overinvolvement rates for S/R and unlicensed drivers are shown in Table 4 and Figure 3. These rates were calculated by dividing the fatal crash involvement ratio for each group by the fatal crash involvement ratio for validly licensed drivers. The overinvolvement rate indicates how much higher (as a times-as-many score) S/R and unlicensed crash involvement ratios are compared to the ratio for the validly licensed group. For example, the upper-bound rate of 4.93 for S/R drivers in 2005 indicates that the crash involvement rate for these drivers was 4.93 times higher than that for validly licensed drivers in that year. As can be seen, the annual rates range from 1.57 to 4.93 for S/R drivers, and from 1.84 to 4.10 for unlicensed drivers. While the rates for both groups fluctuate widely (due to small sample sizes), they exceed 1.0 in every year, indicating that drivers in both groups are consistently more likely than validly licensed drivers to be considered culpable in fatal crashes.

All-Years Group Fatal Crash Involvement Ratios and Overinvolvement Rates

The group fatal crash involvement ratios and sample sizes for 1987 through 2009 combined are shown in Table 5. Combining the yearly data increased the sample sizes and resulted in risk estimates that are more stable than the annual risk estimates. Each cell percentage in the table was calculated by dividing the cell count by the total count for the row. The column and row total percentages were calculated by dividing the total count (for the column or row) by the count for all groups combined. The involvement ratios were calculated for each group by dividing the proportion of at-fault drivers in the group by the proportion of not-at-fault drivers in the group. The resultant involvement ratios are 0.86 (77.5 ÷ 90.1) for validly licensed drivers, 2.23 (13.0 ÷ 5.8) for S/R drivers, and 2.34 (9.5 ÷ 4.1) for unlicensed drivers. Fatal crash overinvolvement rates were calculated by dividing the S/R and unlicensed groups' involvement ratios by the

Table 4
Annual Group Fatal Crash Overinvolvement Rates for Suspended/Revoked (S/R) and Unlicensed Drivers, Relative to Drivers with Valid Licenses, From 1987 through 2009

Year	S/R	Unlicensed
1987	2.90	2.62
1988	1.83	1.96
1989	3.15	4.05
1990	2.89	3.35
1991	1.94	3.58
1992	3.07	2.81
1993	2.84	2.33
1994	2.16	1.90
1995	4.05	2.50
1996	1.57	2.89
1997	2.91	3.85
1998	3.13	4.10
1999	3.14	2.66
2000	2.63	2.31
2001	3.23	4.04
2002	4.27	3.62
2003	2.29	2.63
2004	2.46	2.66
2005	4.93	1.84
2006	2.67	2.79
2007	1.68	2.99
2008	1.89	1.96
2009	2.90	3.06

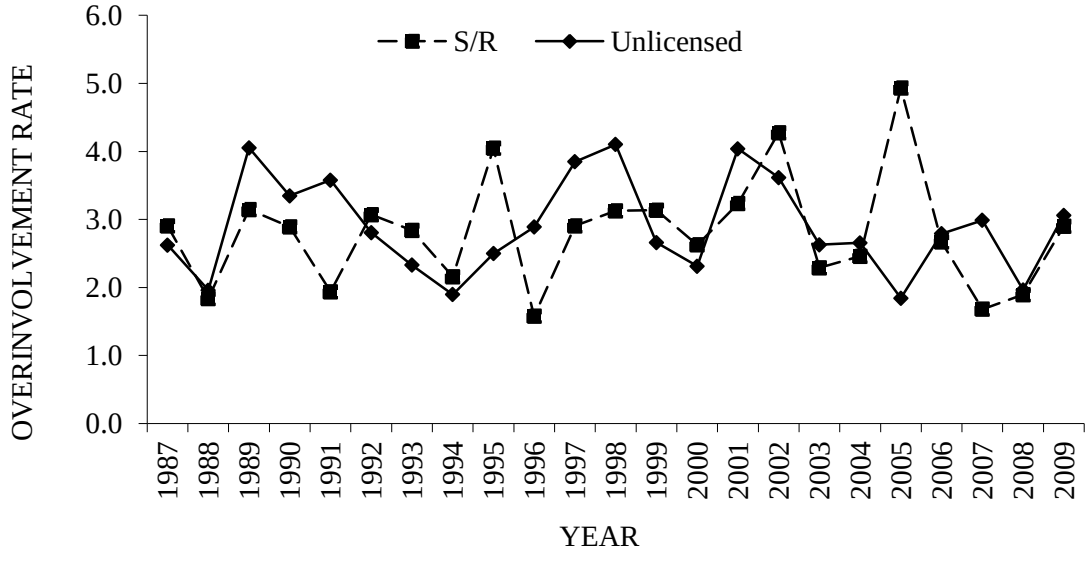

Figure 3. Annual group fatal crash overinvolvement rates for suspended/revoked (S/R) and unlicensed drivers, relative to drivers with valid licenses, from 1987 through 2009.

involvement ratio for the validly licensed group. The resultant 23-year overinvolvement rates for S/R and unlicensed drivers, relative to drivers with valid licenses, are 2.60 (2.23 ÷ 0.86) and 2.73 (2.34 ÷ 0.86), respectively.

Table 5

Number and Percentage of Two-Vehicle Fatal Crashes by License Status of At-Fault and Not-At-Fault Drivers for 1987 through 2009 Combined

License status of at-fault driver	License status of not-at-fault driver			
	Valid	S/R	Unlicensed	Total
Valid	6,191	357	246	6,794
	91.1%	5.3%	3.6%	77.5%
S/R	988	106	45	1,139
	86.7%	9.3%	4.0%	13.0%
Unlicensed	724	47	66	837
	86.5%	5.6%	7.9%	9.5%
Total	7,903	510	357	8,770
	90.1%	5.8%	4.1%	100.0%

Note. A crash involvement ratio was computed for each group by dividing the proportion of at- fault drivers in the group by the proportion of not-at-fault drivers in the group. The resultant ratios are 0.86, 2.23, and 2.34 for validly licensed S/R, and unlicensed drivers, respectively. The fatal crash overinvolment rates, relative to validly licensed drivers are therefore 2.60 and 2.73 for the S/R and unlicensed groups, respectively.

DISCUSSION

This study used the QIE technique to estimate fatal crash involvement ratios (risks relative to exposures) for validly licensed, S/R, and unlicensed drivers in California from 1987 through 2009. For all years combined, the fatal crash involvement ratios of 2.23 and 2.34 for S/R and unlicensed drivers, respectively, are considerably higher than the fatal crash involvement ratio of 0.86 for validly licensed drivers. The overinvolvement rates of 2.60 and 2.73 for the S/R and unlicensed groups, respectively, over all years indicate that drivers in these two groups were nearly three times more likely than validly licensed drivers to have caused fatal crashes relative to their exposures.

Although the extent to which S/R and unlicensed drivers were overrepresented as culpable drivers varied from year to year, their risks were substantially higher than that for validly licensed drivers every year throughout the 23-year period studied. The variability in the annual crash involvement ratios for these two groups is largely due to the small number of fatal crashes involving these drivers each year. The crash involvement ratios for all years combined are considered more reliable than the annual ratios because they are based on a much larger number of fatal crashes. The downside is that the combined-years ratios mask any changes in risk that may have occurred over time due to changes in the composition of the groups and other factors that could have influenced group risk. Regardless of the focus of attention (whether on the annual estimates or the combined-years estimates), the study findings provide strong evidence that S/R and unlicensed drivers are much more likely than validly licensed drivers to cause fatal crashes relative to their exposures.

The QIE analyses conducted in the study by DeYoung et al. (1997), mentioned earlier in this report, computed fatal crash involvement ratios for validly licensed, S/R, and unlicensed drivers involved in two-vehicle fatal crashes in California from 1987 through 1992. That study found involvement ratios of 0.73, 2.68, and 3.58 for these three groups, respectively, and overinvolvement rates for S/R and unlicensed drivers, relative to validly licensed drivers, of 3.7 and 4.9, respectively. For comparison purposes, the current study analyzed fatal crashes for the same years (1987-1992) covered in the earlier study using the QIE method used in the current study. These supplemental analyses found involvement ratios of 0.85, 2.15, and 2.50 for validly licensed, S/R, and unlicensed drivers, respectively, and overinvolvement rates for S/R and unlicensed drivers, relative to valid licensed drivers, of 2.53 and 2.95, respectively.

One reason the risk estimates for S/R and unlicensed drivers from the two studies differ is that the earlier study relied on FARS data to determine fault, while the current study used data from SWITRS for this purpose. Specifically, the prior study considered a driver to be at fault if the driver had been cited for a moving traffic violation leading up to the crash, while the current study used the judgment of the law enforcement officer as the basis for determining fault. This difference in how fault was determined resulted in many crashes that were excluded in the earlier study being included in the current one. For example, the prior study excluded a large number of crashes because both drivers were cited, and many of these crashes were included in the present study because only one of the cited drivers were assigned fault by the law enforcement officer. The fact that citations are rarely issued to drivers who are killed in the crash also makes the use of citations to determine fault problematic.[2] In addition, Jiang, Qui, Lyles, & Zhang (2012) found that driver age and gender, drinking/illegal drug use, and other factors besides culpability increase the likelihood that a crash-involved driver will be issued a traffic citation. Since the current study did a better job of accurately identifying at-fault drivers, the findings presented in this report are considered to be the most valid.

The QIE technique has a few potential methodological limitations that conceivably could have affected the risk estimates. One is the possibility that not-at-fault drivers in fatal collisions are not truly a representative sample of the general driving population as assumed by the technique (Lardelli-Claret et al., 2006). However, Chandraratna and Stamatiadis (2009) have shown that not-at-fault drivers do represent the general driving population well when fault is accurately determined. Since fault in this study was determined by the law enforcement officer investigating the crash and is therefore likely to have been accurately assigned, this QIE assumption is considered to have been sufficiently met.

Another limitation is that only certain types of crashes were included in the QIE analyses, which constrains the ability to generalize the study results to other types of crashes. As previously stated, to be included in the study the fatal crash had to involve only two vehicles, only passenger cars or pickup trucks, one at-fault driver and one not-at-fault driver, and only validly licensed, S/R, or unlicensed drivers. Only about 10% of all fatal crashes in California during the period studied meet all of these criteria and hence were eligible for inclusion in the analyses.

[2]Being correctly cited for a violation in a fatal crash is heavily dependent on whether or not the driver survived the crash. From 1987 through 2009, 40.5% of all drivers in a fatal crash died, and only 2.4% of these killed drivers were cited for a moving violation in FARS. In contrast, of the 59.5% of drivers who survived a fatal crash, 16.9% were cited for a moving violation.

The extent to which the group crash rates found in this study are indicative of the involvement and culpability of these groups in the other 90% of crashes is unknown.

Another factor that had the potential to bias the study findings is the elimination of FARS crashes that failed to match to a unique SWITRS record due to data on the matching variables being missing in SWITRS for one or both drivers. A review of the unmatched crash records found no meaningful association between the data being missing and license status, suggesting that excluding the unmatched crash cases is unlikely to have had a meaningful effect on the risk computations.

A final potential limitation that deserves mention is that S/R and unlicensed drivers may have been more likely to have been falsely assigned fault than were validly licensed drivers due to a possible "negative halo effect," in which the law enforcement officer was more likely to judge a driver to be responsible for the crash if they were not validly licensed (DeYoung et al., 1997). If this occurred, though there is no available data to either refute or support that it did, it could have inflated the crash involvement ratios for the S/R and unlicensed groups. The extent to which this occurred and may have biased the results is unknown. However, it is considered unlikely that a law enforcement officer would knowingly assign fault to an innocent driver just because they were not validly licensed, given the severity of the crash, the consequences to the driver and others of the driver being (falsely) deemed to have caused the crash, and the officer's awareness that they may later be questioned about their crash report in a hearing or judicial proceeding.

In spite of the study limitations mentioned above, the findings presented in this report provide strong evidence that S/R and unlicensed drivers are significantly more hazardous on the road than are validly licensed drivers. In addition, the elevated risk levels for S/R and unlicensed drivers, found every year from 1987 through 2009, do not appear to have systematically changed over this period. Of particular relevance is that the annual overinvolvement rate for unlicensed drivers does not appear to have decreased following implementation of the law that denies licensure to individuals whose presence in California is not authorized under federal law. This latter finding suggests that this segment of the unlicensed driver population is as hazardous as other unlicensed drivers. If such drivers were truly safer, the annual overinvolvement rates for unlicensed drivers generally would be expected to have started to trend downwards following enactment of the law, a pattern which isn't evident in the plot of annual rates in Figure 3. To the contrary, the crash overinvolvement rate for unlicensed drivers as a group actually increased steadily over the 4 years immediately following enactment of the law, and the rates before and after the law are, on average, not noticeably different in elevation.

RECOMMENDATIONS

It is recommended that future studies on the crash risk posed by S/R and unlicensed drivers include, if possible, analyses of single-vehicle and multi-vehicle crashes and crashes involving vehicles other than just cars and pickup trucks. It is also suggested that injury crashes be included in future QIE analyses conducted on these groups. The latter effort would require matching and merging fatal/injury crash records obtained from SWITRS with driver records stored in DMV's Driver Record Master (DRM) file to determine the license status of drivers at the time of the crash. Planning for such a study is already underway by DMV.

Given the strong evidence in this report that S/R and unlicensed drivers continue to represent an elevated safety threat to other road users, it is recommended that available countermeasures aimed at deterring individuals from driving without a valid license and reducing the risks associated with this unlawful behavior continue to be applied. As mentioned in the Introduction section of this report, one treatment that has proven to be highly effective in reducing crashes involving S/R and unlicensed drivers is vehicle impoundment, and therefore the continued use of this countermeasure is recommended.

It is also recommended that efforts continue to be made to develop new strategies that may have promise in controlling S/R and unlicensed driving and reducing associated crashes. Much progress in developing such new countermeasures has already been made as part of California's Strategic Highway Safety Plan (SHSP), which incorporates the inputs of a wide range of traffic safety stakeholders working collaboratively to identify the most pressing traffic safety problems in the state and to find new and effective methods to ameliorate them. One of the 17 SHSP Challenge Areas is focused on ensuring that drivers are properly licensed, and has as its ultimate goal the reduction of fatalities caused by S/R, unlicensed, and improperly-licensed drivers.

REFERENCES

AAA Foundation for Traffic Safety. (2011). *Unlicensed to Kill*. Washington, DC: Author. Retrieved on April 6, 2011 from http://www.aaafoundation.org/pdf/2011Unlicensed2Kill.pdf

Carr, B. R. (1969). A statistical analysis of rural Ontario traffic accidents using induced exposure. *Accident Analysis and Prevention*, 1, 343-357.

Cerrelli, E. C. (1973). Driver exposure – the indirect approach for obtaining relative measures. *Accident Analysis and Prevention*, 5, 147-156.

Chandraratna, S., & Stamatiadis, N. (2009). Quasi-induced exposure method: evaluation of not-at-fault assumption. *Accident Analysis and Prevention*, 41, 308-313.

Clark, B., & Bobevski, I. (2008). *Disqualified drivers in Victoria: Literature review and in-depth focus group study* (Report No. 274). Victoria, Australia: Monash University Accident Research Centre.

DeYoung, D. J. (1999). An evaluation of the specific deterrent effects of vehicle impoundment on suspended, revoked and unlicensed drivers in California. *Accident Analysis & Prevention*, 31(1/2), 45-53.

DeYoung, D. J., Peck, R. C., & Helander, C. J. (1997). Estimating the exposure and fatal crash rates of S/R and unlicensed drivers in California. *Accident Analysis and Prevention*, 29, 17-23.

Gebers, M. A., & DeYoung, D. J. (2002). *An Examination of the Characteristics and Traffic Risk of Drivers Suspended/Revoked for Different Reasons* (Report No. 200). Sacramento, CA: California Department of Motor Vehicles.

Griffin, L. I., & DeLaZerda, S. (2000). *Unlicensed to Kill*. Washington, DC: AAA Foundation for Traffic Safety. Available online at http://www.aaafoundation.org/reports

Hagen, R. E., McConnell, E. J., & Williams, R. E. (1980). *Suspension and revocation effects on the DUI offender* (Report No. 75). Sacramento, CA: California Department of Motor Vehicles.

Jiang, X., Qui, Y., Lyles, R. W., & Zhang, H. (2012). Issues with using police citations to assign responsibility in quasi-induced exposure. *Safety Science*, 50, 1133-1140.

Lardelli-Claret, P., Jimenez-Moleon, J. J., Luna-del-Castillo, J. D., Garcia-Martin, M., Moreno-Abril, O., & Bueno-Cavanillas, A. (2006). Comparison between two quasi-induced exposure methods for studying risk factors for road crashes. *American Journal of Epidemiology*, 163, 188-195.

Roberts, R. (2002). *Number of drivers under license suspension/revocation*. Unpublished memorandum. Sacramento, CA: California Department of Motor Vehicles.

Ross, H. L., & Gonzales, P. (1988). Effects of license revocation on drunk driving offenders. *Accident Analysis and Prevention*. 20(5), 379-391.

Stamatiadis, N., & Deacon, J. A. (1997). Quasi-induced exposure: methodology and insight. *Accident Analysis and Prevention*, 29, 37-52.

Thorpe, J. D. (1964). Calculating relative involvement rates in accidents without determining exposure. *Australian Road Research*, 2, 25-36. Reprinted in *Traffic Safety Research Review*, 11, 3-8 (1967).

U.S. Department of Transportation. (2008). *Traffic safety facts, laws: Vehicle and license plate sanctions* (DOT HS 810 880, 1-5). Available online at http://www.nhtsa.gov/DOT/NHTSA/Communication & Consumer Information/Articles/Associated Files/810880.pdf

U.S. Department of Transportation. (2009). *Traffic safety facts: A compilation of motor vehicle crash data from the Fatality Analysis Reporting System and the General Estimates System* (DOT HS 811 402). Available online at http://www-nrd.nhtsa.dot.gov/Pubs/811402.pdf

U.S. Department of Transportation. (2009a). *Traffic safety facts, research note: Trends in fatal crashes among drivers with invalid licenses* (DOT HS 811 229). Available online at http://www-nrd.nhtsa.dot.gov/Pubs/811229.pdf

Voas, R. B., & DeYoung, D. J. (2002). Vehicle action: Effective policy for controlling drunk and other high-risk drivers? Accident Analysis and Prevention, 34(3), 263-270.

Watson, B. C. (2004). The crash risk of disqualified/suspended and other unlicensed drivers. In Oliver, Dr. John, Williams, Dr. Paul, & Clayton, Dr. Andrew (Eds.) *17th International Conference on Alcohol, Drugs and Traffic Safety*, 8 - 13 August, 2004. Glasgow, UK: Scottish Exhibition and Conference Centre.