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DEPARTMENT OF MOTOR VEHICLES

AN EVALUATION OF THE EFFECT OF GAPS IN LICENSURE ON TRAFFIC SAFETY OUTCOMES SUBSEQUENT TO RENEWAL

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Authors: Kevin J. Limrick PhD
Research and Development Branch
Licensing Operations Division

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14. ABSTRACT

Absent a progressive physical or mental condition, motorists in California are permitted to renew their driver license without submitting to a skills test. This policy applies regardless of how long a customer's license has been expired. Given a lack of published research on the retention of motor skills required of driving, the current study was designed to evaluate the effect of a "gap" in licensure on one's ability to safely operate a motor vehicle. More specifically, it sought to determine whether a gap in a customer's licensing history was associated with crashes and / or convictions subsequent to renewal. To that end, the Department's Driver License Master File was used to identify motorists in California who had a clearly defined gap at some point during their licensing history. These customers were then placed into one of three study groups based upon the length of time it took for them to relicense: 1 to 30 days (n = 6,135), 31 to 365 days (n = 4,688), or greater than 365 days (n = 1,973). A fourth group of drivers, all of whom had not experienced a gap in their licensing history (i.e., those who renewed early), was also identified to serve as a type of quasi-experimental control group. These analyses found that drivers who had a gap of at least 1 year had the same odds of incurring at least one post-renewal conviction as did drivers who renewed early. Logistic regression and Cox proportional hazards models also indicated that gap duration was not a significant predictor of post-renewal crash involvement; drivers in this study were equally likely to experience a post-renewal crash, regardless of how long they were unlicensed. Based on the findings of this report, recommendations are made to maintain current DMV policy and not integrate skills testing as part of the renewal process, absent additional information indicating potential issues of concern (e.g., a progressive vision disorder).

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PREFACE

This report presents the results of an evaluation of the effect of gaps in licensure on driving behavior subsequent to renewal. This report was prepared by the California Department of Motor Vehicles Research and Development Branch. The findings, opinions, and conclusions expressed in this report are those of the author and not necessarily those of the State of California.

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This project was conducted under the general direction of Dr. Bayliss Camp, Research Chief. Mike Gebers, Research Scientist III, provided guidance on both the acquisition and analysis of the data.

EXECUTIVE SUMMARY

Background

- Absent a progressive vision or mental condition, motorists in California are currently permitted to renew their driver license without submitting to a skills test.
- This policy applies regardless of how long a customer's license has been expired.
- An extensive literature review failed to identify studies that evaluated the driving performance of individuals after experiencing a lengthy "gap" in their licensing history.

Project Description

- The current study was designed to address the lack of empirical data on the retention of motor skills required of driving. Specifically, it sought to determine whether a gap in a customer's licensing history was associated with crashes and / or convictions subsequent to renewal.
- This effort would help to determine if skills tests should be given to renewal customers following lengthy periods during which they did not drive.

Methods

- The Department's driver license master file was used to identify motorists in California who experienced a gap at some point during their licensing history. A second group of drivers, all of whom had not experienced a gap in their licensing history (i.e., those who renewed early), were also identified to serve as a type of quasi-experimental control group.
- Drivers who had experienced a gap in their licensing history (n = 12,796) were then placed into one of three study groups based upon the length of time they waited until becoming relicensed (i.e., gap duration): 1 to 30 days after expiration (n = 6,135), 31 to 365 days after expiration (n = 4,688), or greater than 365 days after expiration (n = 1,973).
- Logistic regression was used to evaluate the effect of gap duration on the odds of experiencing a crash or conviction subsequent to renewal. Survival analysis was then used to model the first-crash and first-conviction incidence rates among the four study groups.

Results

- No significant differences were found with respect to the odds of being crash-involved; drivers in this study were equally likely to experience a post-renewal crash, regardless of gap duration.
- No significant differences were found with respect to the rate at which drivers in each study group experienced a post-renewal crash.
- Significant differences were found when comparing the odds of incurring a post-renewal conviction among the four study groups. Drivers who renewed early, as well as those who waited more than 1 year to renew, were significantly less likely to incur a post-renewal conviction when compared to drivers in either of the other two study groups.
- Similarly, drivers who renewed early, as well as those who waited at least 1 year to renew, exhibited significantly lower first-conviction incidence rates when compared to drivers in either of the other two study groups.

Conclusions and Recommendations

- The results of this study appear to suggest that a gap in licensure is not associated with increased crash risk subsequent to renewal.
- Each study group was found to have statistically identical post-renewal crash odds, and the rate at which crashes occurred was invariant across each level of gap duration.
- Drivers who waited longer than 1 year to renew exhibited statistically equivalent post-renewal conviction odds, as well as first-conviction incidence rates, when compared to those who renewed early. In other words, the group of drivers considered to be comparatively more deviant were as likely to be convicted of a post-renewal violation as the safest drivers in the sample. This result is likely due to a heightened likelihood of being suspended/revoked —and thus of reduced driving exposure—among those drivers who waited longer than 1 year to renew.
- It is recommended that DMV maintain its policy and not integrate skills testing as part of the driver license renewal process, absent additional information indicating potential issues of concern (e.g., a progressive vision disorder).

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INTRODUCTION

Background

The present study sought to determine if skills tests should be given to motorists following extended periods during which they did not drive. Stated more academically: How well are skills, specifically motor skills, retained following periods of non-use? This issue is of particular interest to the department, given that skills tests are not currently required of drivers based solely on prolonged gaps in their licensing history.[1] It should be noted that an exhaustive literature search failed to identify published articles in which the retention of motor skills was studied within the context of motor vehicle operation. Rather, the background material presented below is meant to provide a brief introduction to research on the acquisition and retention of motor skills as exhibited within either an academic (i.e., laboratory) or military setting. This is then followed by a description of the current study, as well as the findings and conclusions drawn therefrom.

Historical Perspectives of Skill and Motor Learning

Skill acquisition and retention have been studied within a variety of disciplines for over 100 years. Early investigations (e.g., Bryan & Harter, 1897, 1899; Ebbinghaus, 1885/1964) sought to identify the rudimentary determinants and characteristics of learning curves, as well as the effect of differing schedules of practice on skill acquisition (e.g., Hunter, 1929; McGeoch, 1942; Tolman, 1932). As behaviorism became the dominant theoretical perspective in psychology during the first half of the 20th century, studies on skill focused almost entirely on the stimulus-response (S-R) component of learning. The genesis of this ideology can be traced to the works of J. B. Watson (1913, 1916, 1919), who viewed learning as an assimilation of numerous S-R associations through which behavior is conditioned by the environment to produce the correct response to the stimulus at hand.

The rise of cognitive psychology in the 1960s gave birth to the information-processing view of learning, which, contrary to behaviorism, characterizes the learner as an active participant in the acquisition of knowledge and skills. As noted by Adams (1987), behaviorism viewed the acquisition of motor skills primarily as an, "…automatic, unconscious, and direct strengthening of

[1] While skills tests are required of first-time licensees, and may be required of drivers suspended for a physical or mental (P&M) condition, motorists who simply let their license lapse, for any length of time, are able to renew their license without submitting to such an examination.

a habit connection between a stimulus and response" (p. 43). Theories of motor learning seeded within the cognitivist framework, however, argued that individuals use feedback to appraise their own performance, and, if necessary, to make adjustments to their behavior in order to better suit current task demands.

Contemporary Theory and Taxonomy of Skill and Motor Learning

The contention that feedback is used to nullify performance error is a central tenet of most modern theories of skill and motor learning (Proctor & Van Zandt, 1994). For instance, Adams's (1971) *closed-loop theory* asserts that motor learning results from the interplay between two types of memory that are used when bodily movements are made: the "memory trace" and the "perceptual trace." As described by Proctor and Van Zandt (1994), "The memory trace is a simple motor program used to initiate the movement. The perceptual trace is activated at the beginning of a movement in anticipation of the resulting sensory feedback. It provides the referent for the closed-loop system against which the sensory feedback is compared as the movement is being made. If the feedback differs significantly from the referent, the movement is modified to eliminate error" (p. 322). What this implies is that our perceptual system "expects" specific feedback whenever a bodily movement is made. If the *actual* feedback that is received differs from this expectation, the movement is altered to reduce the disparity.

While Adams's theory (see also Schmidt, 1975) does well to describe the mechanism by which movements (and changes to them) are made, others strove to identify how the acquisition of motor skills changes over time. For example, Fitts (1964; Fitts & Posner, 1967) developed a widely used taxonomy that distinguishes three phases of skill acquisition: cognitive, associative, and autonomous. During the cognitive phase, the learner uses instructions and demonstrations to understand the current task or objective. These distinct pieces of information are then collected and related to one another during the associative phase, whereby procedural routines are generated to guide subsequent behavior. Once in the autonomous phase, these routines become increasingly automatic and less subject to conscious manipulation.

Terminology Used to Describe Skill Acquisition and Retention

Fitts's taxonomy is a valuable framework for describing the general phases through which a learner transits when acquiring a particular skill (see also Rasmussen, 1986). It is of lesser utility, however, when attempting to identify the factors that impact not only how quickly skills are learned, but also how well they are retained. Studies on the acquisition and retention of skills, particularly

motor skills, are often rooted in applied settings (e.g., military). As demonstrated below, these efforts have produced a number of findings that are relevant to understanding the underlying nature of motor skill attainment, as well as the importance of training and practice on the retention and transfer[2] of those skills.

Prior to this exposition, however, several key terms commonly used within the published literature need to be highlighted and defined. For instance, motor tasks are often classified as *discrete*, *continuous*, *procedural*, or *verbal* (Druckman & Bjork, 1991), and this delineation is based primarily upon the required response of the learner. *Discrete motor tasks* are those that have a clearly defined beginning and end, such as pressing a button or pulling a lever, and are typically completed in less than 5 seconds. *Continuous motor tasks*, as the name would imply, are those that require repeated movements that often do not have a discernible beginning or end. Examples of continuous tasks involved in (for example) driving include the visual tracking of the roadway, as well as the manipulation of the steering wheel when guiding the vehicle. *Procedural motor tasks* are those typically comprised of a number of discrete operations that must be completed in a specific order each time the task is attempted (e.g., shifting gears of a manual transmission). With respect to procedural motor tasks, Schendel, Shields, and Katz (1978) comment that, "Usually the learner's main problem on each trial is selecting the correct response from a repertoire of possible responses rather than actually executing the response. The learner's main problem is determining "what to do" rather than "how to do it" (p. 14). Finally, *verbal motor tasks* are those that require a vocalized response from the learner. Such responses can range from complex prose, to simple, nonsense syllables. These distinctions are made here because, as will be demonstrated below, the proficiency with which motor skills are acquired and retained is heavily contingent upon the type of motor task that is being performed.

Meta-Analytic Findings of Skill Acquisition and Retention

Given the volume of studies conducted on skill and motor learning over the past 100 years, a recounting of each is beyond the scope of this document. As such, what follows is an assemblage of findings taken from three relatively recent meta-analyses conducted on the acquisition and retention of motor skills (Farr, 1986; Prophet, 1976; Schendel, Shields, & Katz, 1978):

[2] Often, the goal of training is not simply to engender behavior required of one specific situation, but rather to afford the learner the ability to apply acquired skills in variety of situations. For example, many skills required of driving, such as manipulating the brake and accelerator pedals, should be applicable (i.e., transferable) to any number of motor vehicles, regardless of make and model.

- Procedural tasks are forgotten rapidly over days, weeks, or months, while continuous control tasks are retained for months or years (Adams & Hufford, 1962; Cotterman & Wood, 1967; Gardlin & Sitterley, 1972; Mengelkoch, Adams, & Gainer, 1960, 1971; Prophet, 1976; Sitterley, 1974; Smith & Matheny, 1976; Stelmach, 1974; Wright, 1973).

- The retention of motor skill is highly dependent upon the level of initial learning (Fleishman & Parker, 1962; Gardlin & Sitterley, 1972; Naylor, Briggs, & Reed, 1962).

- Increasing the amount of original training can greatly improve retention (Hammerton, 1963; Melnick, 1971; Naylor & Briggs, 1961).

- The more complex or integrated (i.e., hierarchical) a skill is, the more likely it is to be retained (Gentile & Nacson, 1977; Noble, Trumbo, Ulrich, & Cross, 1966; Swink, Trumbo, & Noble, 1967).

- Individuals are able to achieve higher levels of retention if they possess higher initial learning ability (Carron, 1971; Carron & Marteniuk, 1970; Hagman & Rose, 1983; Purdy & Lockhart, 1962).

- The longer the retention interval,[3] the greater the loss of skill (Gardlin & Sitterley, 1972; Hurlock & Montague, 1982).

- The rate at which a skill declines can be lessened if even a minimal investment in mental rehearsal or "imaginary practice" is made during the retention interval (Annett, 1979; Naylor & Brigg, 1961).

- The time needed to retrain an individual to initial proficiency is typically less than one-half of the original training time (Ammons et al., 1958; Hill, 1914; Mengelkoch, et al., 1971), though this time will be extended for more difficult tasks (Lersten, 1969) and for longer retention intervals (Ammons, et al., 1958; Neumann & Ammons, 1957).

The findings presented above highlight a number of variables that impact the acquisition and retention of motor skills. Chief among them was that procedural skills decline more rapidly than do continuous skills. What implications do these results have within the current context? The answer is, unfortunately, unclear at this point. Little if any research has been conducted on the retention of motor skills as they pertain to driving, and the majority of studies cited above, those which may have some relevance to the current topic, were conducted using tasks of greater

[3] The length of time between the end of initial training and subsequent testing.

complexity (i.e., flight). Thus, the findings obtained therefrom are not directly applicable to the comparatively simplistic task of driving. Furthermore, flying an aircraft involves a lengthy and highly proceduralized set of tasks that have to be accomplished in a specific order (i.e., flight plans), executed in many instances (e.g., during spaceflight) over hours, days, or even weeks. Driving, on the other hand, is a predominantly continuous task, in that the majority of the driver's efforts are devoted to the tracking of his/her position on the road. Within this domain, higher-order cognitive functioning is less often relied upon, and is typically availed only in response to an unexpected occurrence (e.g., missing an exit, utilizing detours, assessing potential hazards).

Current Study

The current study was designed to address the lack of empirical data on the retention of motor skills required of driving. Specifically, it sought to determine whether a gap in a customer's licensing history was associated with crashes and / or convictions subsequent to becoming relicensed. If the skills required of driving do in fact deteriorate over lengthy periods of non-use, then customers who experience longer gaps should, theoretically, exhibit higher rates of both crashes and convictions compared to those with shorter (or no) gaps. Such findings would contribute not only to the published literature, but potentially driver licensing policy as well, given that (as mentioned above) the California DMV does not currently require drive tests of customers based solely on lapses in their licensing history.

METHOD

Identification of Study Participants

The sampling procedure used in this study was designed to identify motorists in California who had a clearly defined lapse at some point during their driving history. To that end, a random sample of customers was obtained from the department's Driver License Master File (n = 518,670), though a given record was *removed* if it met any of the following conditions:

- The record indicated the customer was in possession of a commercial license.
- The record was classified as an 'X' record (e.g., the individual was cited for a traffic violation while being unlicensed).
- The record indicated the customer was deceased.
- The record was for an ID card.
- The record contained an out-of-state reply code, indicating the customer had obtained licensure in another state.

The remaining entries were scrutinized further, specifically with regard to the most recent licensing action: a record was *retained* if the most recent licensing action, as displayed on the customer's driving history, indicated either an in-office renewal or renewal by mail. This was to ensure that the most recent license issuance *date* corresponded with the dissemination of a renewed license, rather than, for example, a duplicate license with an updated photo. This is important to note because this particular date (i.e., the issuance date of the most recent license) was used in conjunction with the expiration date of the *previous* license to calculate the gap in a customer's licensing history.[4] Those who had experienced a gap in their licensing history (n = 12,796) were then placed into one of three study groups based upon the length of time they waited until becoming relicensed (i.e., gap duration): 1 to 30 days after expiration (n = 6,135), 31 to 365 days after expiration (n = 4,688), or greater than 365 days after expiration (n = 1,973). While there lacked any *a priori* justification for having stratified the sample in this manner, doing so appeared logical within the context of evaluating the effect of short (up to 30 days), intermediate (31 days to 365 days), and longer (greater than 365 days) licensing gaps on subsequent driving behavior. It

[4] Gap duration = issuance date of the current license – expiration date of the previous license.

should also be noted that a random sample of customers (n = 12,797), all of whom had *not* experienced a gap in their licensing history (i.e., those who renewed early), was also identified to serve as a type of quasi-experimental control group.

Data Sources

Data on the study participants' demographics and driving history were extracted from the Driver License Master File on July 8th, 2016. Crash involvements and traffic convictions were counted separately for five time periods relative to the date of renewal: 2 years prior, 1 year prior, 6 months post, 1 year post, and 2 years post. Data obtained during the 2 years preceding the date of renewal were used to compare each group on prior driving history. Crash and conviction statistics accumulated during the post-relicensing periods were then used to investigate the effect of gap duration on short (6 months), intermediate (1 year), and longer-term (2 years) driving behavior. It should be noted that the sample was limited to include only those whose renewal date occurred *prior* to January 1st, 2012. This design decision was due to the fact that California Highway Patrol (CHP), the agency tasked with updating crash and conviction data to DVM, is typically at least 1 year behind in providing these data to the department.[5]

Data Analyses

Logistic regression was used to evaluate the effect of gap duration on 2-year subsequent crashes and convictions. These outcome variables were dichotomized for each participant to indicate whether or not at least one crash or conviction occurred during the post-renewal periods. Sex, age, study group membership, and prior driving history were used as predictors in these models. Group-by-age and group-by-sex interaction terms were also included to determine if the effect of gap duration was different for men and women, or for participants of different ages. Likelihood ratio tests were used to evaluate overall model fit, and Wald chi-square tests and an alpha level of .05 were used to assess the statistical significance of each predictor. Odds ratios were also calculated to demonstrate the multiplicative change in the odds of experiencing a post-renewal crash or conviction given a 1-unit change in each predictor variable.

To supplement these logistic regression models, Cox Proportional Hazards survival analyses were used to differentiate, among the four study groups, first-crash and first-conviction incidence rates

[5] CHP is responsible for providing crash and conviction counts that the department uses to update the DRM. However, due to staffing shortages and furloughs of non-sworn CPH personnel, reporting of these statistics to DMV has historically been delayed.

during the 2-year post-renewal period. Age, sex, study group membership, and prior driving history were used as predictors in each Cox regression model. Group-by-age and group-by-sex interaction terms were also included to determine if first-crash and first-conviction incidence rates differed for men and women, or for participants of different ages.

RESULTS

Descriptive Statistics

Table 1 presents various demographic and driver record statistics for each of the four study groups. The pre-expiration driver record variables represent incidents that occurred during the 2 years preceding the date of expiration, whereas the post-renewal variables represent those incidents occurring 2 years subsequent to the date of renewal.

Table 1

Descriptive Statistics for each Study Group

	Study Group			
Risk Group	Renewed early(control) *N* = 12,797	Renewed w/in 30 days *N* = 6,135	Renewed 31-365 days *N* = 4,688	Renewed +365 days *N* = 1,973
Age (mean)	51.01	44.86	44.56	46.42
Male (%)	48.59	50.90	52.69	58.49
Days to renewal (mean)	-42.04[a]	10.17	108.97	1,330.63
2-year pre-expiration driver record (per 100)				
Suspended / revoked	2.07	6.31	14.59	32.44
Convictions	37.73	57.39	62.35	41.05
Major Convictions	0.52	1.08	2.11	2.28
Convictions while S/R	0.40	1.40	4.74	11.96
Crashes	11.93	13.15	13.12	4.06
Crashes while S/R	0.05	0.16	0.75	0.56
APS Suspension	0.18	0.52	0.96	1.12
Negligent operator points	17.41	32.13	38.07	28.31
2-year post-renewal driver record (per 100)				
Suspended / revoked	0.70	2.56	4.71	5.88
Convictions	19.14	27.14	29.71	24.33
Major convictions	0.02	0.05	0.09	0.15
Convictions while S/R	0.13	0.20	0.62	0.81
Crashes	6.79	7.47	7.36	5.32
Crashes while S/R	0.01	0.05	0.15	0.10
APS suspension	0.02	0.03	0.00	0.00
Negligent operator points	8.42	14.07	15.58	12.39

[a]This indicates that, on average, those who renewed early did so approximately 42 days prior to the date of expiration

The vast differences seen in the driver record data in Table 1 are, presumably, a consequence of customers "self-selecting" themselves to a particular study group. And while the non-randomization of participants precludes any causal inference regarding these (or subsequent) findings, the data provided above are nonetheless informative. For instance, the overall rate of suspended/revoked (henceforth "S/R") drivers at 2 years prior to expiration was nearly 16 times higher for those who waited at least 1 year to relicense compared to those who renewed early. It was also found during the pre-expiration periods that drivers who waited at least 1 year to relicense incurred convictions at a rate comparable to those in the other study groups, while at the same time crashing much less frequently (overall). Customers who waited at least 1 year to relicense were also more likely than those in the other study groups to be convicted of driving while S/R during the pre-renewal periods (Figure 1).

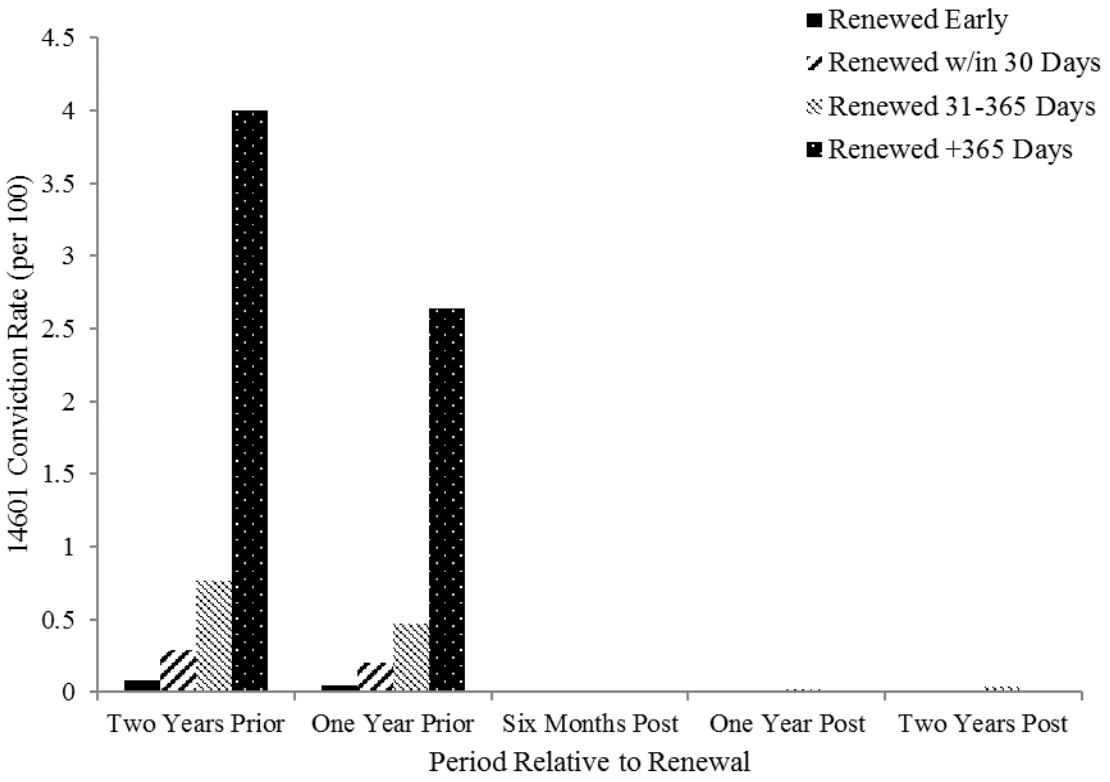

Figure 1. 14601 conviction rate (per 100).

Figure 1 also highlights a common finding with respect to the post-renewal periods; here, we see a dramatic decline in nearly every metric presented in Table 1 at 2 years post-renewal compared to 2 years pre-expiration (see Appendix). Though speculative, this finding would appear to suggest that requiring motorists to be in contact with the DMV may be somewhat effective in regulating subsequent driver behavior.

Effect of Gap Duration on Subsequent Crash Involvement

The effect of gap duration on subsequent crash involvement was evaluated by entering age, sex, study group, and prior driving history into a logistic regression analysis. Group-by-age and group-by-sex interaction terms were also included as predictors, but were removed due to non-significant findings ($p > .05$). The fit of this model was statistically significant ($p = .0001$), and as illustrated in Table 2, age, prior convictions, and prior crashes were reliable predictors of crash involvement ($p < .05$). Study group was found to be non-significant ($p = .1098$), indicating that gap duration was not a reliable predictor of post-renewal crash involvement.

Table 2

Summary of Logistic Regression Predicting 2-Year Subsequent Crash Involvement

Predictor	Regression coefficient	Standard error	Wald χ^2	*p*	Odds ratio	95% confidence interval
Intercept	-2.5750	0.1379	348.51	.0001*	___	___
Age	-0.0040	0.0017	5.47	.0193*	0.996	0.993-0.999
Sex	0.0179	0.0514	0.12	.7279	1.018	0.921-1.126
Study group	___	___	6.04	.1098	___	___
Prior S/R status	-0.0647	0.1016	0.41	.5240	0.937	0.768-1.144
Prior convictions	0.2255	0.0254	78.68	.0001*	1.253	1.192-1.317
Prior major convictions	-0.4292	0.2550	2.83	.0923	0.651	0.395-1.073
Prior crashes	0.3205	0.0583	30.25	.0001*	1.378	1.229-1.544

Note. $\chi^2(9, N = 25{,}593) = 149.72$, $p = .0001$. Coding: Sex 0 = women, 1 = men; Suspension / revocation indicator 0 = suspended, 1 = not suspended.
*$p < .05$.

Effect of Gap Duration on Subsequent Convictions

The effect of gap duration on subsequent convictions was evaluated by entering age, sex, study group, and prior driving history into a logistic regression analysis. Group-by-age and group-by-sex interaction terms were also included as predictors, but were removed due to non-significant findings ($p > .05$). The fit of this model was statistically significant ($p = .0001$), and as illustrated

in Table 3, age, sex, study group, prior S/R status, prior convictions, prior major convictions, and prior crashes were all reliable predictors of post-renewal convictions ($p < .05$).

Table 3

Summary of Logistic Regression Predicting 2-Year Subsequent Convictions

Predictor	Regression coefficient	Standard error	Wald χ^2	p	Odds ratio	95% confidence interval
Intercept	-1.0450	0.0884	139.91	.0001*	___	___
Age	-0.0174	0.0012	226.82	.0001*	0.981	0.981-0.985
Sex	0.3184	0.0338	88.70	.0001*	1.375	1.287-1.469
Study group	___	___	27.27	.0001*	___	___
Prior S/R status	-0.1740	0.0631	7.59	.0059*	0.840	0.743-0.951
Prior convictions	0.4414	0.0178	613.23	.0001*	1.555	1.502-1.610
Prior major convictions	-0.3322	0.1431	5.39	.0203*	0.717	0.542-0.950
Prior crashes	0.2005	0.0422	22.56	.0001*	1.222	1.125-1.327

Note. $\chi 2(9, N = 25{,}593) = 1468.96$, p = .0001. Coding: Sex 0 = women, 1 = men. Suspension / revocation status 0 = suspended, 1 = not suspended.
*p < .05.

Separate odds ratios were then calculated to compare the effect of gap duration on subsequent convictions among each of the four study groups. As presented in Table 4, customers who renewed early were significantly less likely to incur a conviction when compared to those who renewed within 30 days ($p = .0001$), as well as those who renewed between 31 and 365 days after expiration ($p = .0001$). It was also found that customers who waited at least 1 year to renew were significantly less likely to incur a conviction when compared to those who renewed within 30 days ($p = .0192$), as well as those who renewed between 31 and 365 days after expiration ($p = .0053$). Interestingly, the probability of incurring at least one post-renewal conviction was statistically equivalent when comparing customers who renewed early to those who waited at least 1 year ($p = .9025$). Similar results were found when comparing those who renewed within 30 days to those who renewed between 31 and 365 days after expiration ($p = .4899$).

Table 4

Odds Ratios Comparing the Effect of Gap Duration on Subsequent Convictions

Study Group	Regression coefficient	Standard error	Wald χ^2	*p*	Odds ratio	95% confidence interval
Renewed early vs renewed w/in 30 days	-0.1595	0.0413	14.93	.0001*	0.853	0.786-0.924
Renewed early vs renewed 31-365 days	-0.1932	0.0452	18.27	.0001*	0.824	0.754-0.901
Renewed early vs renewed +365 days	0.0085	0.0693	0.02	.9025	1.009	0.878-1.064
Renewed w/in 30 days vs renewed 31-365 days	-0.0338	0.0489	0.48	.4899	0.967	0.878-1.064
Renewed w/ 30 days vs renewed +365 days	0.1680	0.0717	5.48	.0192*	1.183	1.028-1.361
Renewed 31-365 days vs renewed +365 days	0.2017	0.0723	7.78	.0053*	1.224	1.062-1.410

Note. The second study group in each comparison represents the referent group for that comparison.
*$p < .05$.

Effect of Gap Duration on Time-to-First Subsequent Crash

A Cox proportional hazards model was used to identify whether subsequent first-crash incidence rates differed among the four study groups. Covariates of interest included age, sex, study group, and prior driving history. Group-by-age and group-by-sex interaction terms were initially included in the analysis, but were removed due to non-significant results ($p > .05$). The fit of this model was statistically significant ($p = .0001$), with age, prior convictions, prior crashes, and prior admin per se suspensions all serving as reliable predictors ($p < .05$) of first-crash incidence rates (see Table 5).

Table 5

Results of the Cox Proportional Hazards Model Predicting Time-to-First Crash

Predictor	Regression coefficient	Standard error	Wald χ^2	*p*	Hazard ratio	95% confidence interval
Age	-0.0039	0.0016	5.61	.0179*	0.996	0.993-0.999
Sex	0.0206	0.0498	0.17	.6799	1.021	0.926-1.125
Study group	—	—	6.95	.0736	—	—
Prior S/R status	-0.0593	0.0950	0.39	.5324	0.942	0.782-1.135
Prior convictions	0.2073	0.0237	76.61	.0001*	1.230	1.175-1.289
Prior crashes	0.2998	0.0542	30.57	.0001*	1.350	1.213-1.501
Prior APS suspensions	-1.0699	0.5068	4.46	.0348*	0.343	0.127-0.926

Note. χ^2 (9, *N* = 25,593) = 149.80, *p* = .001. Coding: Sex 0 = women, 1 = men. Suspension / revocation status 0 = suspended, 1 = not suspended.
*$p < .05$.

Study group was found to be non-significant ($p = .0819$), indicating that first-crash incidence rates were equivalent regardless of gap duration. This finding is depicted graphically in Figure 2, wherein the survival rate for each study group is plotted as a function of time. It should be noted that while Figure 2 may appear to suggest that delaying relicensure beyond 1 year results in lower first-crash incidence rates, the finding that study group was not a significant predictor of first-crash incidence rates (as mentioned above) nullifies this contention.

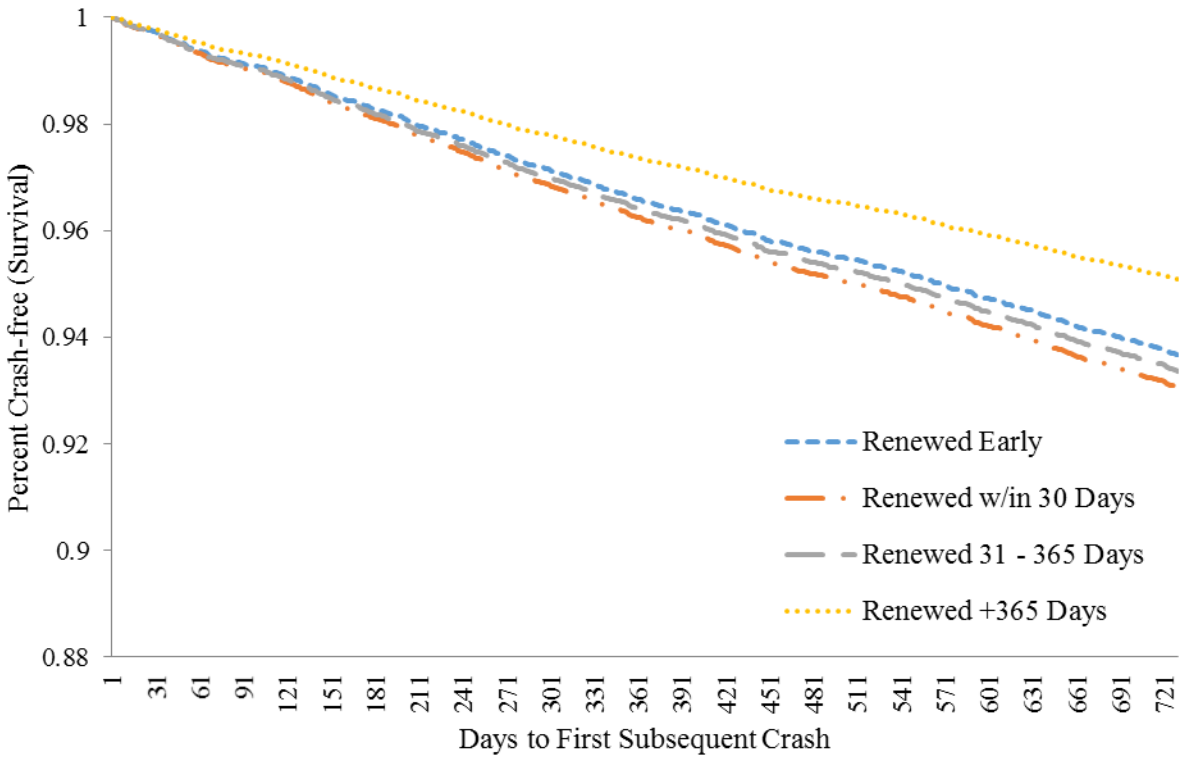

Figure 2. Cox survival distributions of time-to-first subsequent crash.

Effect of Gap Duration on Time-to-First Subsequent Conviction

A Cox proportional hazards model was used to identify whether subsequent first-conviction incidence rates differed among the four study groups. Covariates of interest included age, sex, study group, and prior driving history. Group-by-age and group-by-sex interaction terms were initially included in the analysis, but were removed due to non-significant results ($p > .05$). The fit of this model was statistically significant ($p = .0001$), with age, sex, study group, prior S/R status, prior convictions, prior crashes, and prior crashes while S/R all serving as reliable predictors ($p < .05$) of first-conviction incidence rates (see Table 6).

Having identified study group as a significant predictor of subsequent first-conviction incidence rates, survival curves were generated to graphically illustrate the nature of this finding (see Figure 3).

Table 6

Results of the Cox Proportional Hazards Model Predicting Time-to-First Conviction

Predictor	Regression coefficient	Standard error	Wald χ^2	*P*	Hazard ratio	95% confidence interval
Age	-0.0153	0.0010	219.44	.0001*	0.985	0.983-0.987
Sex	0.2815	0.0301	87.63	.0001*	1.325	1.249-1.405
Study group	—	—	28.21	.0001*	—	—
Prior S/R status	-0.1183	0.0513	5.32	.0211*	0.888	0.803-0.982
Prior convictions	0.3343	0.0123	743.01	.0001*	1.397	1.364-1.431
Prior crashes	0.1555	0.0352	19.48	.0001*	1.168	1.090-1.252
Prior APS suspensions	0.3203	0.1644	3.80	.0514	1.378	0.998-1.901
Prior crashes while S/R	-0.5447	0.1940	7.88	.0050*	0.580	0.397-0.848

Note. χ^2 (10, N = 25,593) = 1442.97, p = .001. Coding: Sex 0 = women, 1 = men. Suspension / revocation status 0 = suspended, 1 = not suspended.
*p < .05.

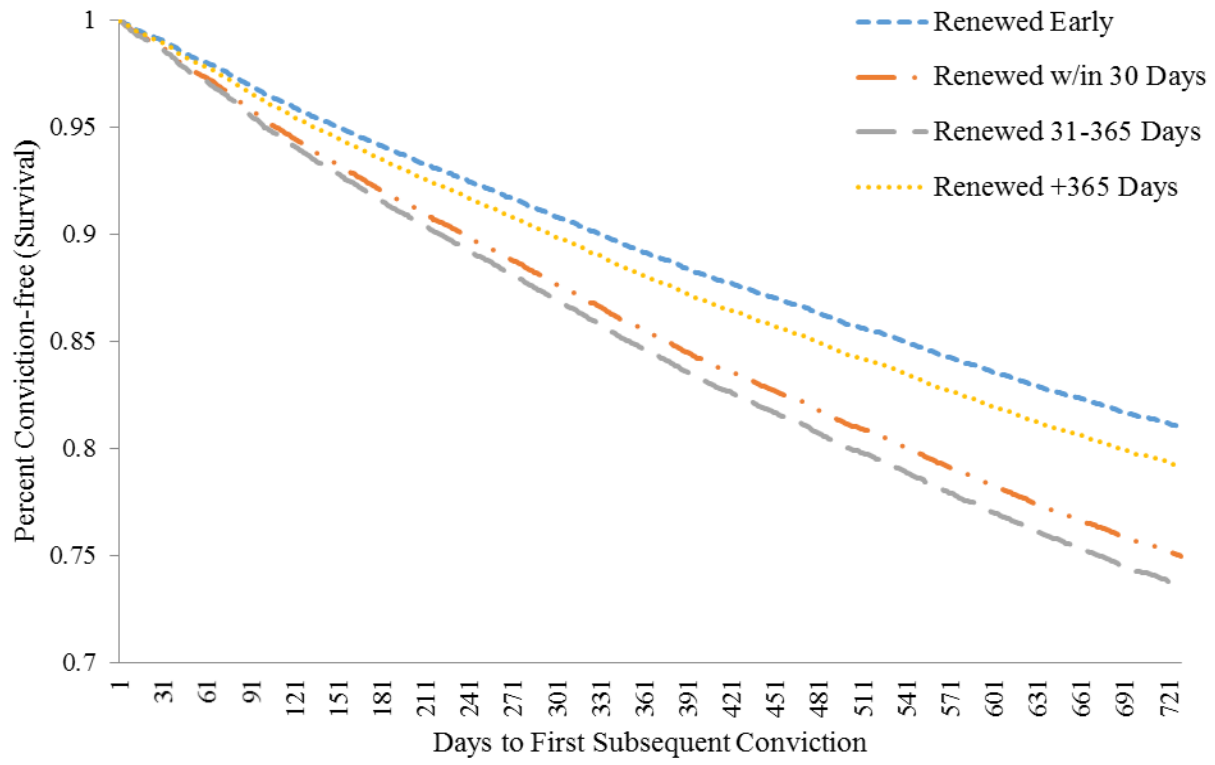

Figure 3. Cox survival distributions of time-to-first subsequent conviction.

Hazard ratios were then used to compare the survival distributions among the four study groups. These results, presented below in Table 7, indicate that customers who renewed early exhibited significantly lower first-crash incidence rates when compared to those who renewed within 30 days (p = .0001), as well as those who renewed between 31 and 365 days after expiration (p = .0001). It was also found that customers who waited at least 1 year to renew had significantly lower first-crash incidence rates compared to those who renewed within 30 days (p = .0080), as well as those who renewed between 31 and 365 days after expiration (p = .0021). No significant difference was found when comparing the first-crash incidence rate of those who renewed early to those who waited at least 1 year (p = .6646). Similar results were found when comparing those who renewed within 30 days to those who renewed between 31 and 365 days after expiration (p = .5051).

Table 7

Hazard Ratios Comparing the Effect of Gap Duration on Time-to-First Subsequent Conviction

Study Group	Regression coefficient	Standard error	χ^2	p	Hazard ratio	95% confidence interval
Renewed early vs renewed w/in 30 days	-0.1401	0.0362	14.98	.0001*	0.869	0.810-0.933
Renewed early vs renewed 31-365 days	-0.1680	0.0394	18.19	.0001*	0.845	0.783-0.913
Renewed early vs renewed +365 days	0.0266	0.0612	0.19	.6646	1.027	0.911-1.158
Renewed w/in 30 days vs renewed 31-365 days	-0.0279	0.0418	0.44	.5051	0.973	0.896-1.056
Renewed w/ 30 days vs renewed +365 days	0.1667	0.0627	7.03	.0080*	1.181	1.044-1.336
Renewed 31-365 days vs renewed +365 days	0.1946	0.0632	9.48	.0021*	1.215	1.073-1.375

Note. The second study group in each comparison represents the referent group for that comparison.
*p < .05.

DISCUSSION

General Discussion of Findings

The results presented above appear to indicate that a gap in licensure, in and of itself, is not associated with an increase in crash risk subsequent to renewal. The odds of being crash-involved, as well as the rate at which crashes were experienced, were equivalent regardless of gap duration. Significant differences begin to emerge, however, when evaluating the effect of gap duration on post-renewal convictions. Here, we see that the two most-seemingly disparate groups of drivers – those who renewed early, and those who renewed after waiting at least 1 year – exhibited significantly lower conviction odds and first-conviction incidence rates subsequent to renewal when compared to drivers in either of the other two study groups.

These results are likely due, not to both groups containing equally safe drivers, but rather to S/R status. Consider the pre-expiration driver record statistics presented earlier in Table 1. These figures clearly demonstrate that drivers who renewed early were comparatively better (i.e., safer) than those in any other study group. Conversely, drivers in the group that waited the longest to renew could be characterized as the most deviant, given that, as mentioned above, a substantial number (32%) were already S/R prior to the expiration of their license term. The potential impact of S/R status is further evidenced below in Table 8, which indicates that the group that waited the longest to renew had, across the three post-renewal study periods, an S/R rate 8 to 10 times higher than the group that renewed early. This severely limited the exposure of the group that waited the longest to renew, and as a result, fewer convictions were incurred than would have otherwise been expected.

Table 8

S/R Rate during the Post-Renewal Periods

	S/R rate (per 100)		
Study group	6 months post	1 year post	2 years post
Renewed early	0.31	0.41	0.70
Renewed w/in 30 days	0.90	1.55	2.56
Renewed 31-365 days	2.35	3.54	4.71
Renewed +365 days	2.59	4.06	5.88

Study Limitations

One of the biggest limitations of this project is that participants self-selected themselves to a particular study group. This precludes any causal assertions to be made about the effect of gap duration on future driving behavior, though the nature of this kind of study does not often lend itself to rigorous experimental methodology (i.e., random selection / assignment). Perhaps even more detrimental to the interpretation of the above findings is the possibility of people driving while they were unlicensed. As mentioned earlier, the placement of participants into one of the four study groups was based solely on the length of time they waited until becoming relicensed. This difference in time-to-renewal served as the basis for all of the analyses described above, and is the epoch of time during which the "forgetting" of driving skill was postulated to occur. If participants continued to drive while unlicensed, however, any post-renewal comparisons based upon gap duration would be rendered meaningless.

To determine the extent of unlicensed riding among members of each study group, a number of additional data extractions were conducted. Presented conceptually in Figure 4, this analysis used the renewal date of each participant as a starting point, and, working backwards to their date of expiration, tabulated the number of 14601 convictions accrued over that period. This effort was cumbersome for two reasons. First, expiration and renewal dates were unique to each participant. Second, R&D's data extraction program mandates that at least one time period be specified from which data would be obtained *for the entire group*. As such, individual expiration and renewal dates could not be used to define the data extraction periods. Given these constraints, the decision was made to use the range of gap duration specific to each study group, identify the first, second, and third quartiles of that range, and then use *those* data to delineate the epochs during which 14601 convictions were counted for each participant.

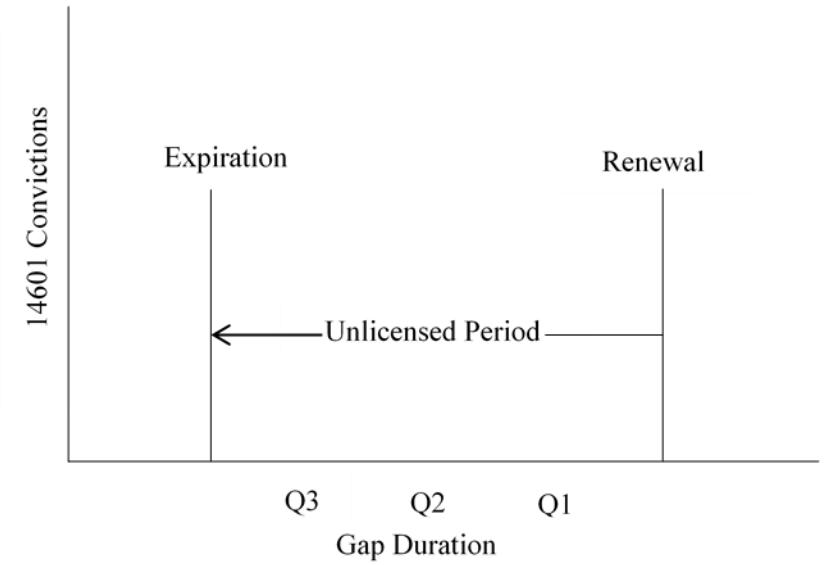

Figure 4. Schematic of the 14601 data extraction protocol.

What was discovered was that a small proportion of drivers in two of the study groups continued to drive while they were unlicensed (see Table 9), and as a result, retained the very skills that were assumed to decline over this period. It is worth noting that these figures probably represent the lower-bound estimate of unlicensed driving, given that not everyone who drove S/R was caught. Regardless, the fact that unlicensed driving occurred at all alludes to a potentially large and unaccounted source of variance that should be considered when interpreting the results of this study.

Table 9

14601 Conviction Rates during Expiration Period (per 100)

Study group	1st Quartile	2nd Quartile	3rd Quartile
Renewed w/in 30 days	0	0	0
Renewed 31-365 days	0	0	0.04
Renewed +365 days	2.18	3.65	7.65

Conclusions

The results of this study appear to suggest that a gap in licensure, in and of itself, is not associated with increased crash risk. Each study group was found to have statistically identical post-renewal crash odds, and the rate at which crashes occurred was invariant regardless of gap duration. Significant differences begin to emerge when evaluating the odds and incidence rates of convictions, though not in the way one might expect. Here, we see that those who waited longer than 1 year to renew exhibited statistically equivalent post-renewal conviction odds, as well as first-conviction incidence rates, when compared to those who renewed early. In other words, the group of drivers considered to be comparatively more deviant was as likely to be convicted of a post-renewal violation as the safest drivers in the sample, though as mentioned above this result is likely due in part to S/R status.

Given the results of this study, it is recommended that DMV maintain its policy and not integrate skills testing as a routine part of the driver license renewal process, absent additional information indicating potential issues of concern (e.g., a progressive vision disorder).

Suggestions for Future Research

Prior research has demonstrated that procedural motor skills decline more rapidly than do continuous control skills. To examine whether this paradigm exists within the context of motor vehicle operation, future research could attempt to classify types of crashes and convictions as being “more procedural” (i.e., cognitive) or “more continuous” (i.e., physical), and then model the effect of gap duration on the odds and rates of these transgressions. Given the findings of the meta-analyses reported earlier, one could expect crashes and convictions involving more of a cognitive component to occur more frequently, and at a faster rate, compared to those involving more of a physical component.

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APPENDIX

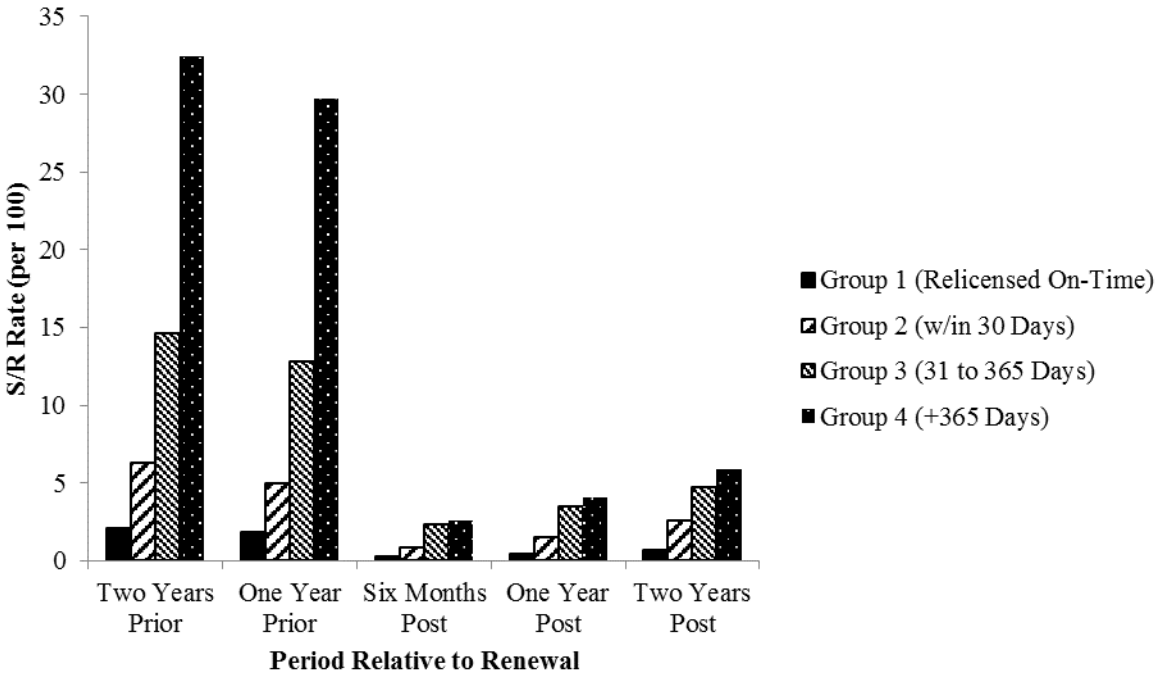

Figure A1. Study group differences in presence of suspension/revocation.

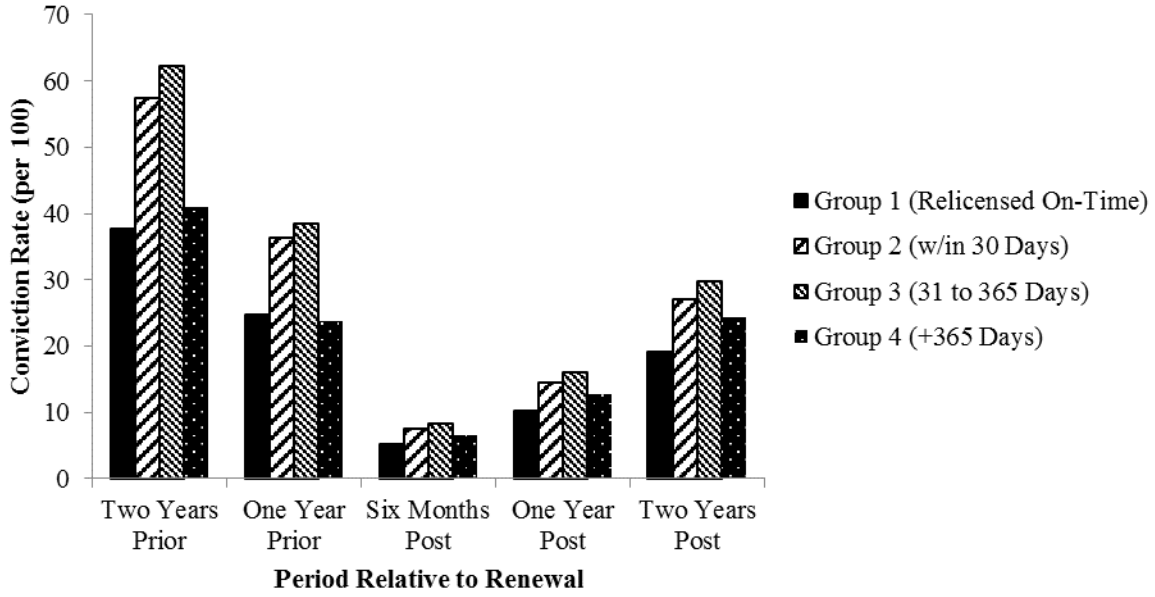

Figure A2. Study group differences in number of total convictions.

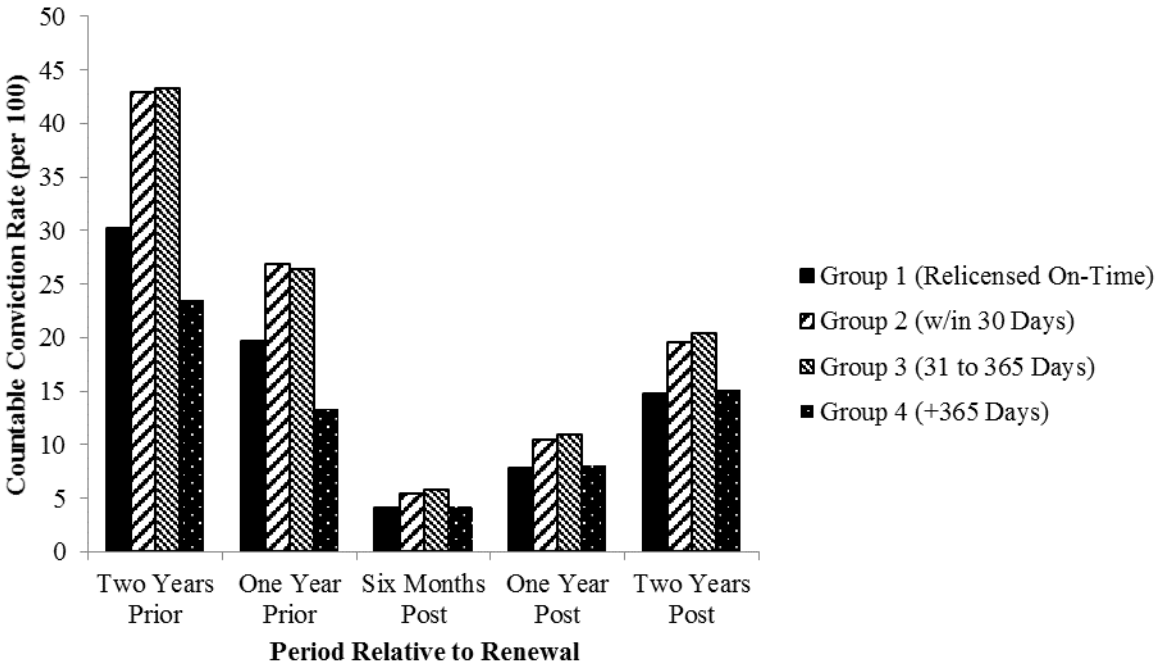

Figure A3. Number of countable convictions.

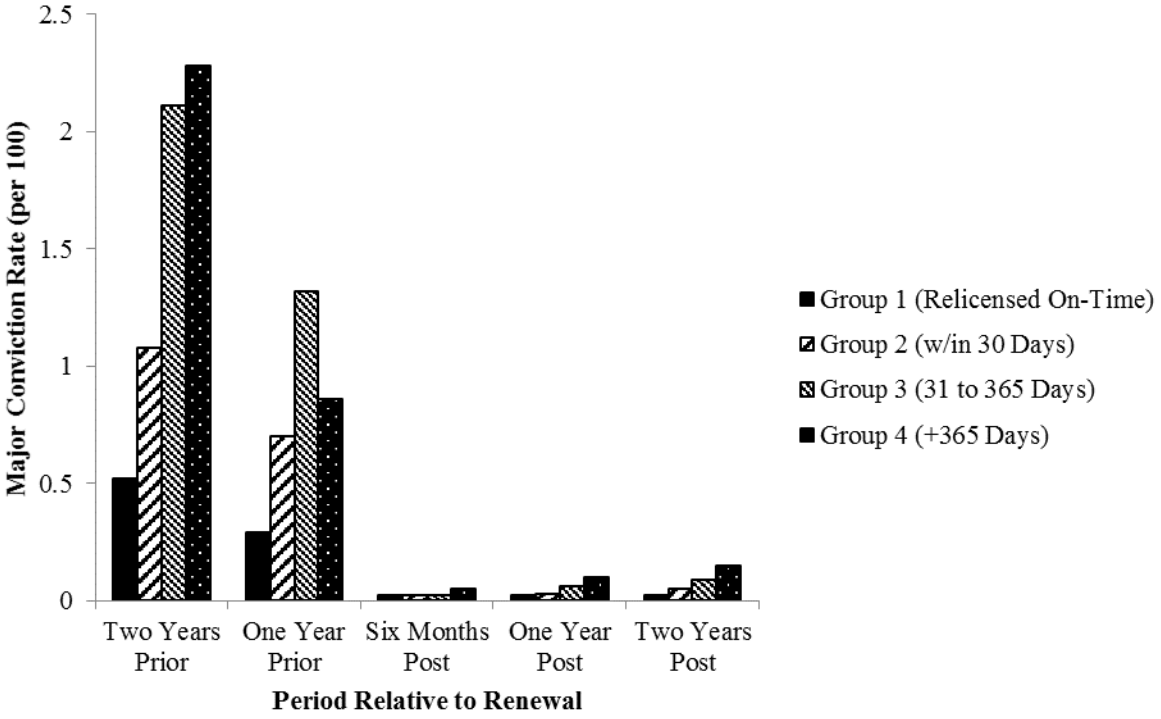

Figure A4. Number of major convictions.

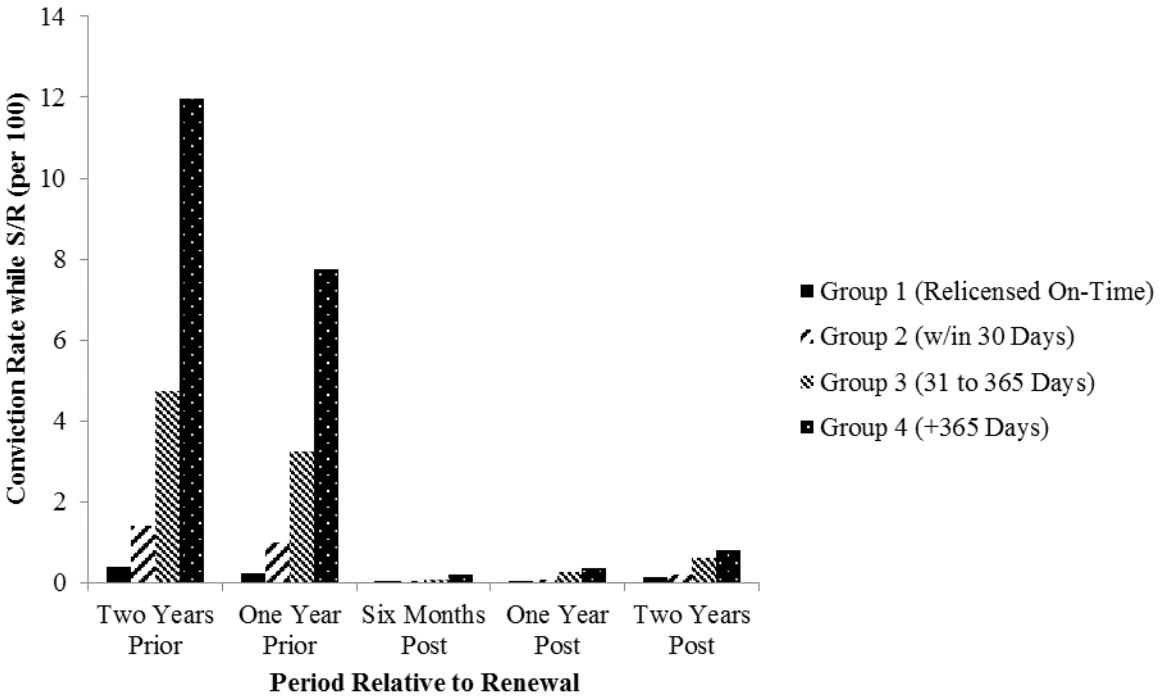

Figure A5. Convictions while suspended/revoked.

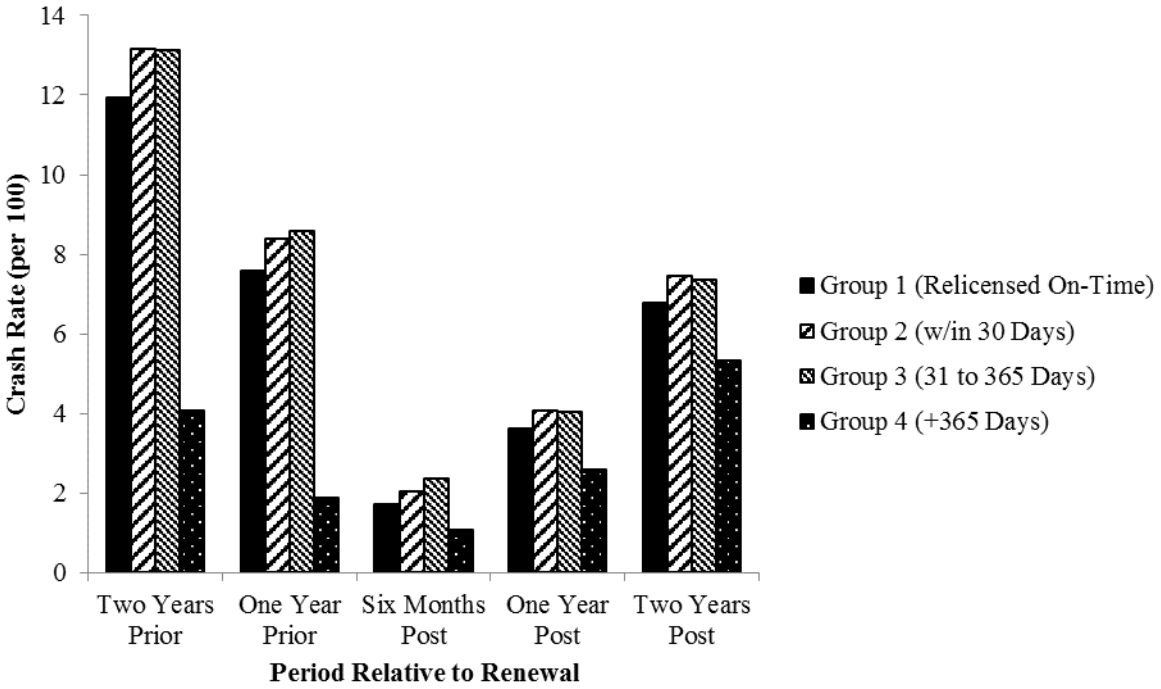

Figure A6. Number of total crashes.

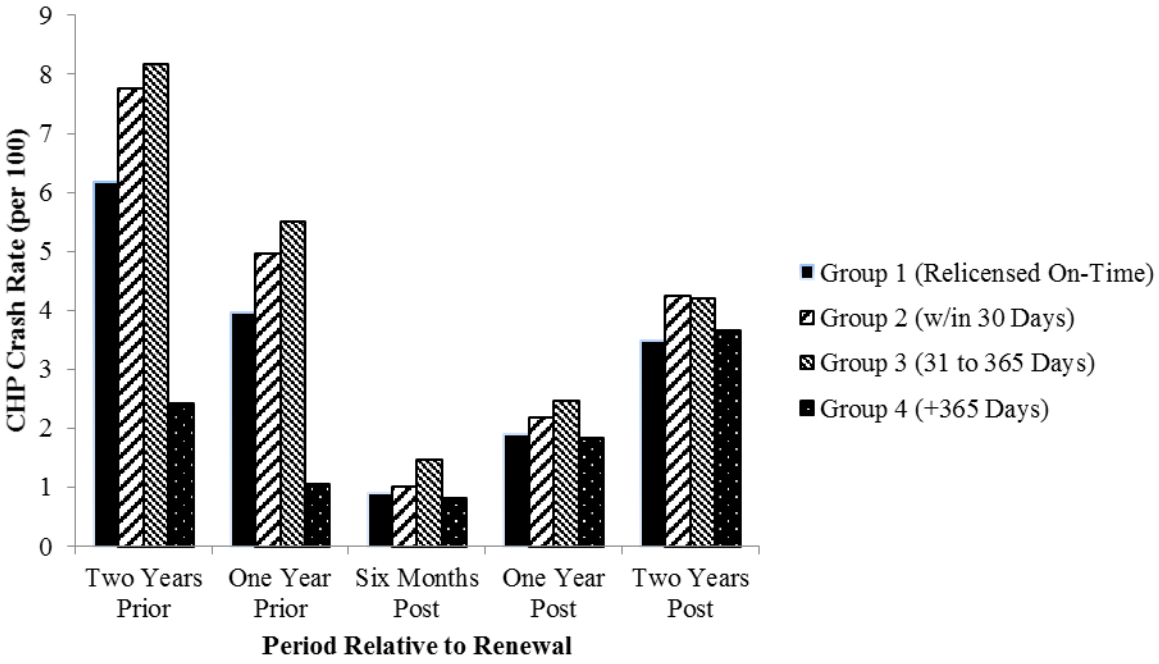

Figure A7. Number of total CHP crashes.

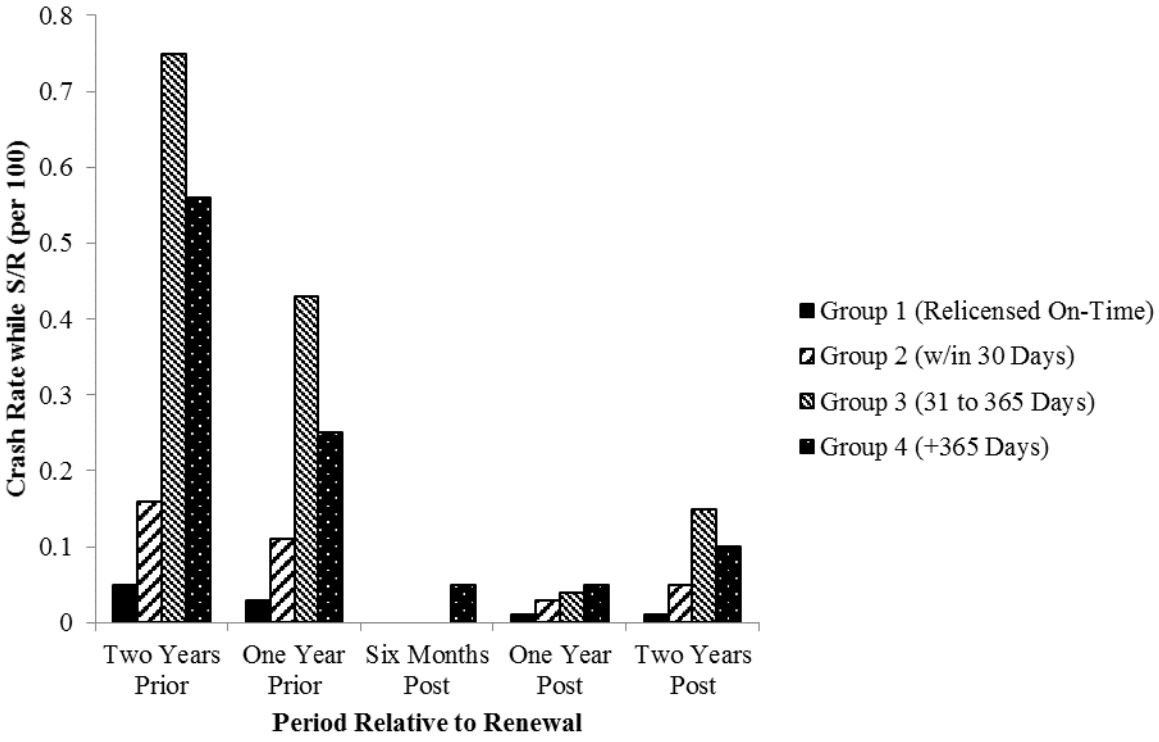

Figure A8. Number of Crashes while suspended/revoked.

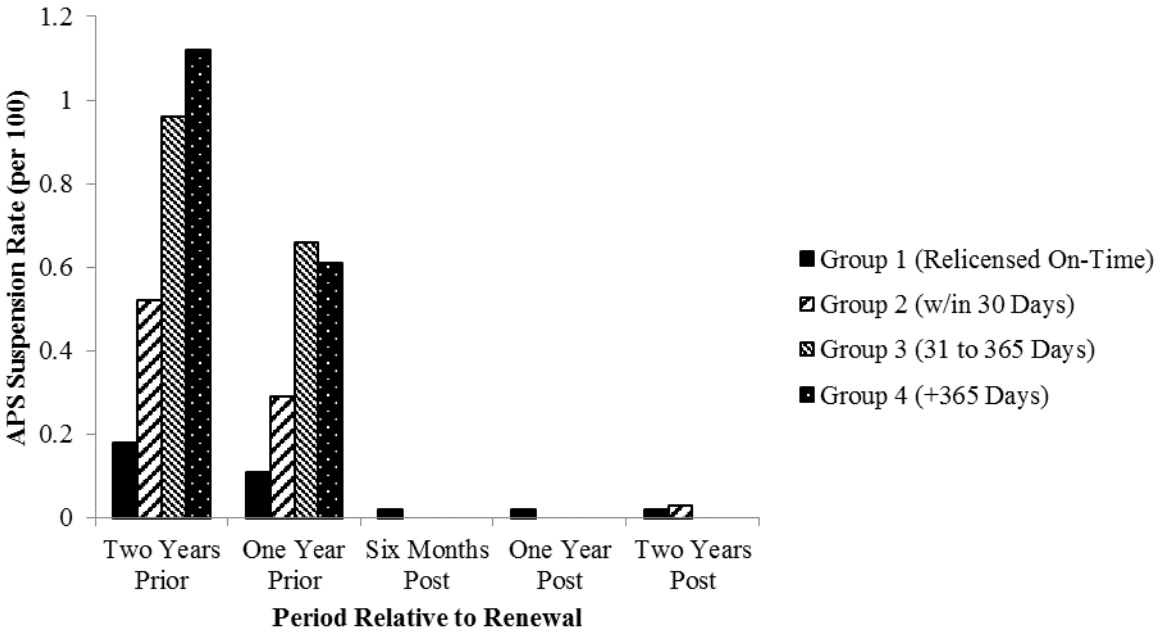

Figure A9. Number of APS suspensions.

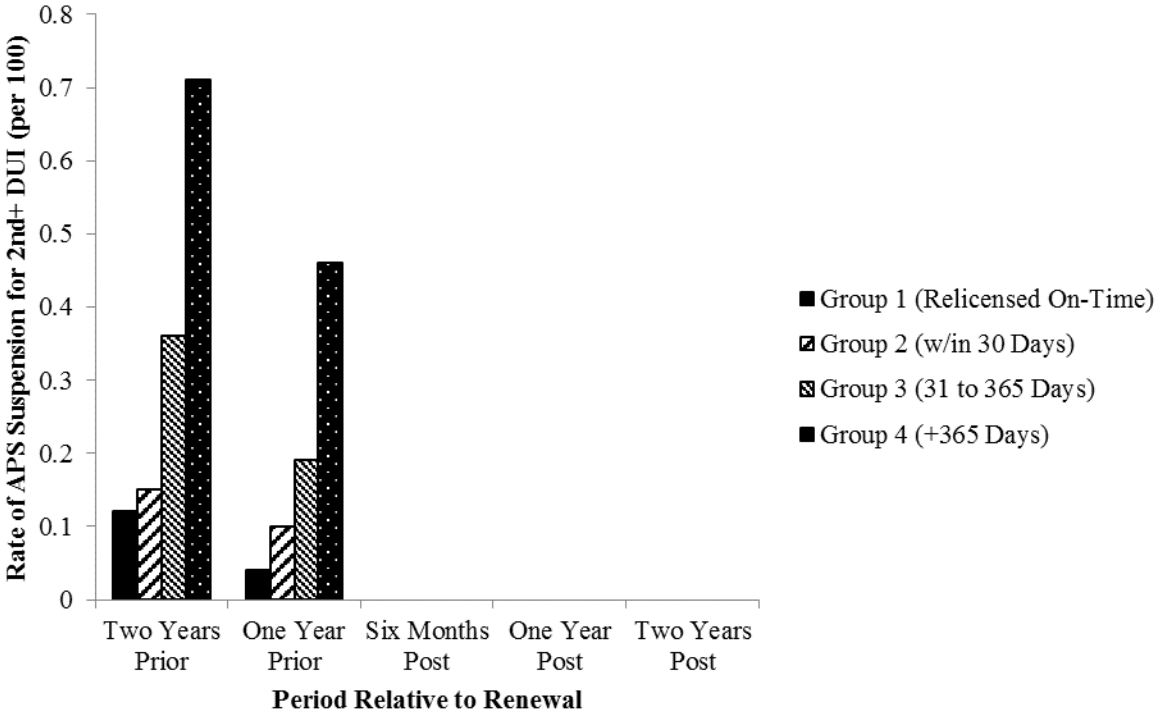

Figure A10. Number of APS suspensions for 2nd+ DUIs.

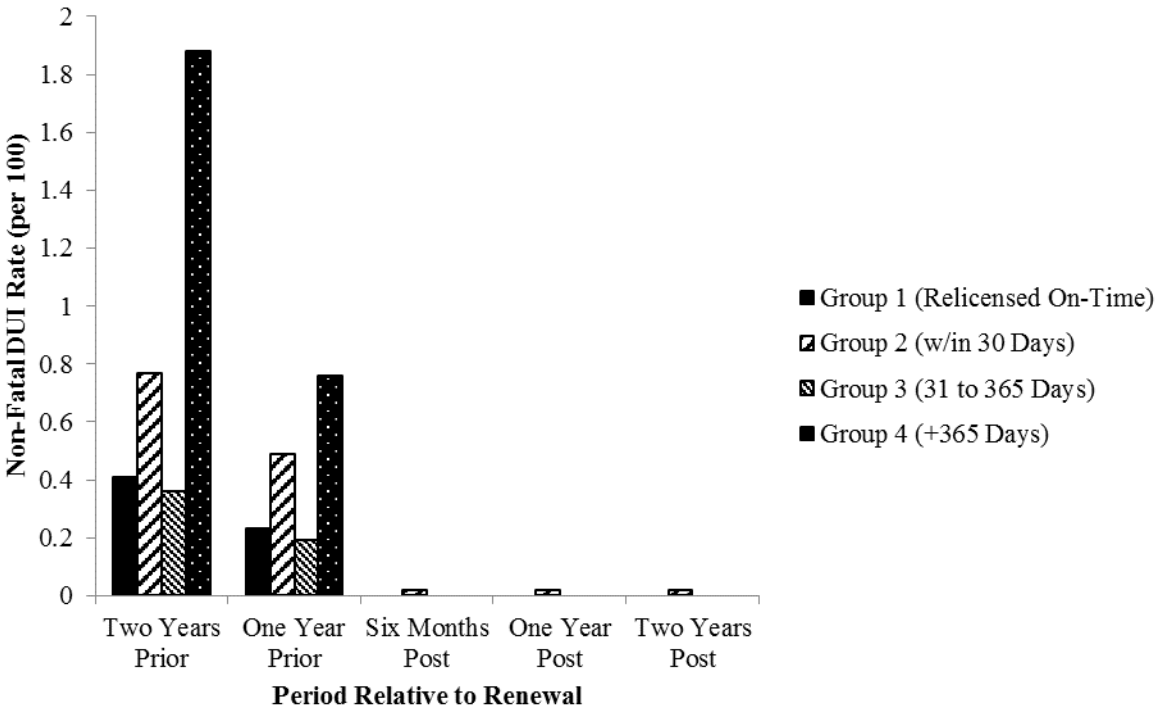

Figure A11. Number of non-fatal DUIs.

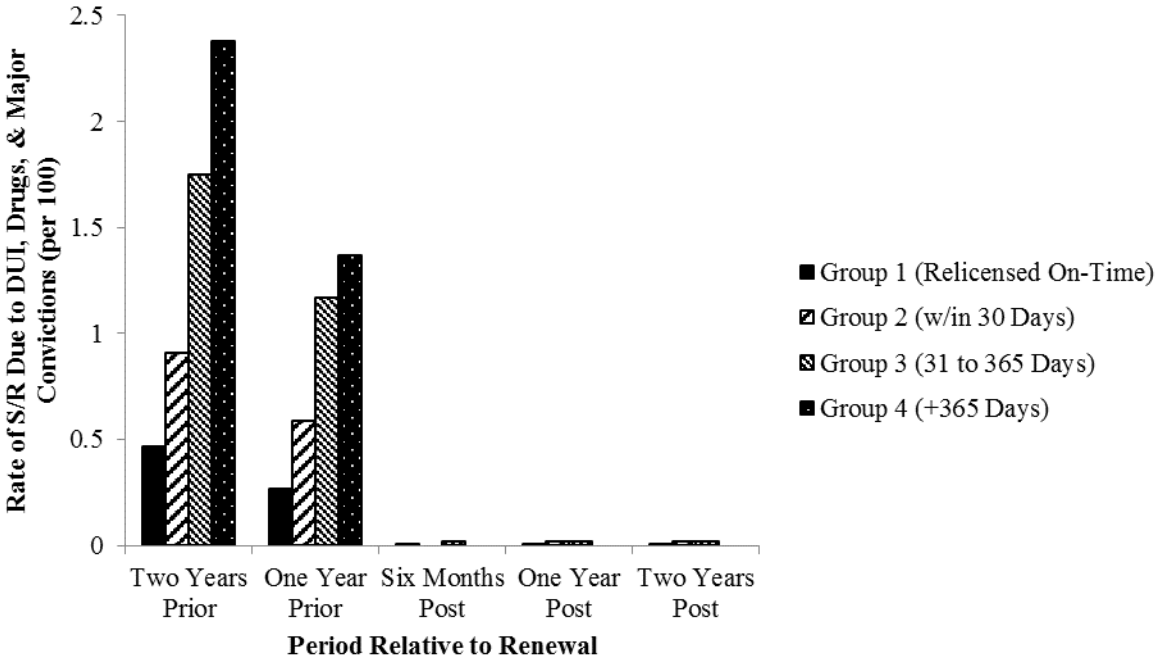

Figure A12. Suspension/revocation due to DUI, Drugs.

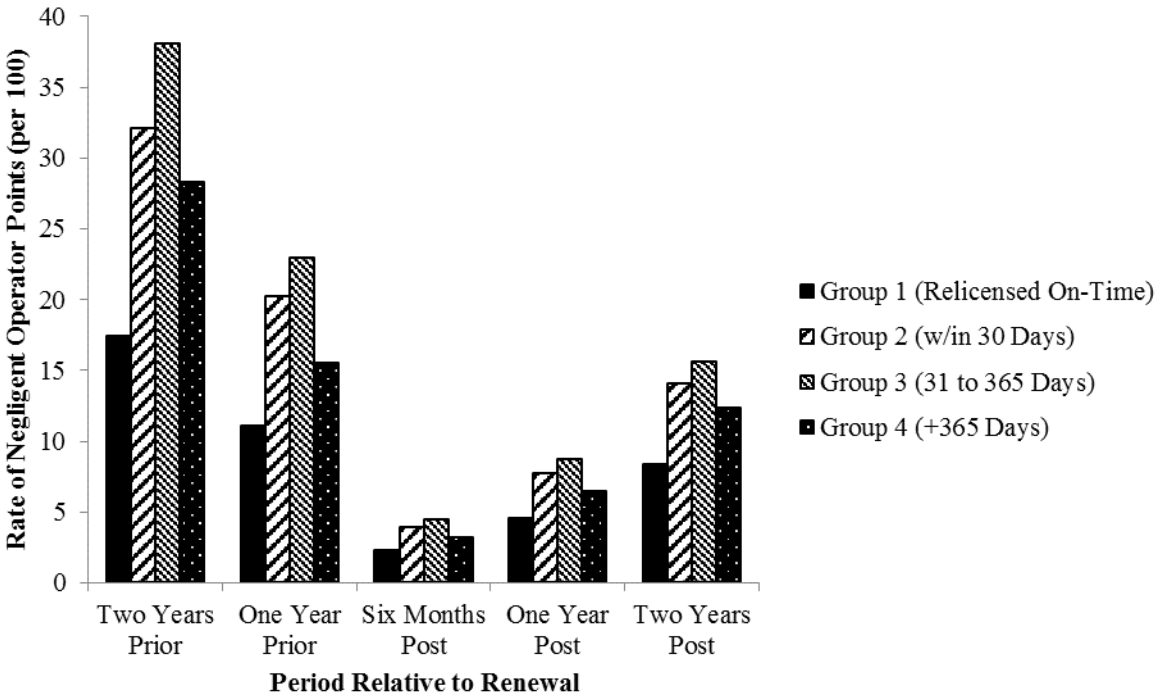

Figure A13. Number of negligent operator points.