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Young driver compliance with Graduated Driver Licensing restrictions before and after implementation of a decal provision

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Abstract

Introduction—In May 2010, New Jersey implemented the first-in-the-nation decal provision to increase intermediate drivers' compliance with Graduated Driver Licensing restrictions and ultimately reduce young driver crashes. We previously found that the provision was associated with a 9.5% decline in crash rates. This study evaluates whether the decal provision was associated with an increase in compliance with passenger and nighttime restrictions.

Methods—We analyzed NJ driver licensing and crash data from 2008–2012. We used the quasi-induced exposure method to estimate prevalence of noncompliance among 20,593 non-responsible 17- to 20-year-old intermediate drivers involved in crashes. Multivariate log-binomial regression models compared the monthly prevalence of noncompliance with restrictions pre- and post-implementation, adjusted for age, sex, season, and area income and population density. Analyses were conducted in 2016–2017.

Results—Overall estimated noncompliance with the nighttime restriction was 1.75% before and 1.71% after the decal provision ($p=0.83$). Noncompliance with the passenger restriction was 8.68% before and 8.31% after ($p=0.35$). Introduction of the decal provision was not associated with a change in noncompliance rates.

Conclusions—Compliance rates among NJ intermediate drivers were high both before and after the decal provision. Findings do not suggest that the decline in crash rates following

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implementation was due to increased compliance with nighttime or passenger driving restrictions. Additional research is needed to understand mechanisms by which decal provisions may reduce young driver crashes.

Keywords

probationary drivers; Graduated Driver Licensing; vehicle identifier

Motor vehicle crashes are the leading cause of death among US adolescents.¹ To address this public health issue, state-level Graduated Driver Licensing (GDL) systems restrict intermediate (i.e., newly licensed) drivers from driving in higher-risk conditions, which include driving at night and with multiple passengers, while on-road experience is gained.² National GDL evaluations have indicated that these restrictions are effective at reducing fatal crashes involving adolescents.^{3–5} However, enforcement of GDL restrictions by police requires a traffic stop and visual inspection of the driver's license. This may limit both police enforcement of and young drivers' compliance with GDL passenger and nighttime restrictions and ultimately limit the effectiveness of GDL in reducing crashes.^{6,7}

In an effort to improve the effectiveness of GDL, numerous international jurisdictions have introduced provisions requiring these drivers to display a vehicle identifier indicating their intermediate license status.⁸ The causal pathways by which decal provisions have been hypothesized to reduce crashes is depicted in Figure 1. Decal provisions are hypothesized to encourage young intermediate drivers' compliance with GDL nighttime and passenger restrictions and avoidance of other higher-risk driving behaviors, subsequently reducing crashes.⁹ Further, improving the ability of police to enforce these restrictions may be expected to improve drivers' future willingness to comply with GDL restrictions or drive safer. However, the impact of decal provisions on intended outcomes—compliance, enforcement, and ultimately crashes—had not been rigorously examined.

On May 1, 2010, New Jersey (NJ) implemented the US's first decal provision, which required all drivers under the age of 21 with a learner's permit or intermediate license to display red, reflectorized decals on their front and back license plates while driving. Several previous studies have evaluated NJ's decal provision.^{10–12} Two studies we previously conducted indicated a sustained 9.5% decrease in police-reported crashes among intermediate drivers over the first two years after implementation and an increase in police enforcement that was primarily limited to the first year post-implementation.^{10,13} With respect to compliance with nighttime and passenger restrictions, a study that conducted telephone and online surveys of NJ intermediate drivers before and after the provision found that the proportion who reported violating nighttime and passenger restrictions in the past month actually increased from the pre- to post-decal period.¹² However, surveys likely overestimate the true extent of young road users' noncompliance as they reduce what is theoretically a continuous measure—the proportion of miles or trips in which a driver did not comply—into a categorical (e.g., ever: yes/no) or ordinal (e.g., how often: Likert scale) variable.¹⁴ Additionally, low response rates may have limited representativeness and generalizability. Finally, the study reported that drivers' awareness of the new GDL requirements increased in the post-decal period, increasing the potential that response-shift

bias may have influenced pre-post survey compliance estimates. Thus, the hypothesis that decal provisions lead to increased compliance with GDL restrictions among intermediate drivers has not yet been rigorously evaluated.

Our objective was to evaluate the association between implementation of NJ's decal provision and the rate of young intermediate drivers' compliance with passenger and nighttime restrictions. Specifically, we analyzed a unique linked data warehouse containing statewide driver licensing and crash report data to determine whether compliance changed in the two years after the provision compared with the two-year pre-provision period.

METHODS

New Jersey GDL System

New Jersey's GDL system was introduced in 2001 and requires all new drivers under the age of 21 to progress through three licensing phases: learner's permit, intermediate license, and full license.¹² Under NJ's current GDL program, residents are eligible for an intermediate license at age 17 following a minimum six-month learner's permit phase; intermediate licenses are subject to a one-year holding period. During this phase, drivers are limited to one passenger unless a parent/guardian is in the vehicle and are prohibited from driving from 11:01 p.m. through 4:59 a.m. With proper documentation, NJ intermediate drivers are eligible for exemption from the nighttime restriction for employment or religious reasons. In addition, beginning on May 1, 2010, young drivers with a learner's permit or intermediate license are required to purchase (US\$4) and display a pair of red, reflectorized decals on both license plates; all intermediate drivers were subject to the provision when it went into effect (i.e., no "grandfathering"). Notably, two other changes in NJ's GDL system occurred at the same time as the decal requirement (in May 2010): (1) a lowering of the nighttime restriction from midnight to 11:01 p.m.; and (2) removal of the exclusion for household members from the one passenger limit when unaccompanied by a parent or guardian—that is, driving multiple siblings without a parent/guardian was no longer exempt.¹² At a minimum of age 18 and following the intermediate license holding period, drivers are eligible for a full (unrestricted) license and must present to a licensing office to initiate this transition.

Data Sources

We analyzed data from the New Jersey Traffic Safety Outcomes (NJ-TSO) data warehouse, which contains linked data from two administrative sources—the NJ Motor Vehicle Commission's Licensing Database and the NJ Department of Transportation's Crash Database.¹⁰ Detailed information on the process and validation of this linkage is available elsewhere.^{10,15} In all, 98.4% of crash-involved NJ drivers under 21 were matched to a unique licensing record. The NJ-TSO data warehouse includes for every NJ driver over an 11-year period (2004-2014) the exact dates of the intermediate license period as well as involvement in police-reported crashes.

Outcome Measures

Main study outcomes were the proportion of trips among intermediate drivers that were not in compliance with NJ's nighttime and passenger restrictions. The prevalence of noncompliance was estimated using a novel application of the quasi-induced exposure (QIE) method—a traffic safety method originally developed to estimate driving exposure in the absence of other exposure data such as vehicle-miles travelled.^{16,17} The primary assumption of QIE is that non-responsible drivers in “clean” multi-vehicle crashes, or crashes with one and only one responsible driver, are randomly selected from the driving population at the time and place of the crash. Non-responsible drivers were those who had no crash-contributing driver actions (e.g., inattention, unsafe speed) noted on their crash report.¹⁸ In a series of previous papers, we demonstrated that this assumption is valid for the population of young intermediate drivers in NJ and that compliance with passenger and nighttime restrictions can be estimated using the QIE method.^{11,14,19} Using these previously established methods, we identified all non-responsible 17-to 20-year-old intermediate drivers who were involved in a clean crash involving at least two vehicles from May 1, 2008 through April 30, 2012. For each study month, the prevalence of trip-level noncompliance was estimated as I_i/N , where i is the restriction of interest, N is the total number of non-responsible intermediate drivers involved in clean multi-vehicle crashes, and I_i is the number of these non-responsible intermediate drivers who were not in compliance with restriction i at the time of their crash. I_i was assumed to follow a binomial distribution.

The two-year pre-decal period was defined as May 2008 through April 2010 and two-year post-decal period defined as May 2010 through April 2012. To ensure appropriate comparison across the study periods, we defined the nighttime restriction period as midnight through 4:59 a.m. in both the pre- and post-decal periods. To further explore the potential contribution of the nighttime restriction change, the proportion of intermediate driver trips that occurred from 11:01pm through 11:59pm was also estimated. Noncompliance with the passenger restriction in both time periods is defined as driving with more than one passenger in the vehicle unless accompanied by a parent or guardian. Given that we were not able to confirm the presence of a parent/guardian, we conservatively estimated noncompliance based on the presence of more than one passenger when no passenger was aged 35 or older.

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Independent Variables

Age and sex were obtained from the licensing record. Zip code of residence at the time of the crash was obtained from the crash record. We used the 2011 American Community Survey and 2010 Census Gazetteer Files to categorize NJ zip codes into quintiles of income (median household income) and population density (people per square mile).^{20–22}

Statistical Analysis

The overall estimated prevalence of noncompliance was compared across time periods and between driver subgroups using the chi-square statistic. Further, we used log-binomial regression to directly compare estimated prevalence by decal period while controlling for confounders and to assess changes over time.^{23,24} A variable for combined month and year (“month-year”) allowed for the examination of trends in noncompliance over time. We also

created an interaction term between month-year and the decal period to test for a difference in the monthly rate of change in noncompliance between the two time periods. To visually depict noncompliance in the post-decal period that would be expected given pre-decal rates (i.e., the counterfactual condition), we used pre-decal data to calculate the predicted probability of noncompliance (p_i) for each trip in the post-decal period. These were then summed for each month to get a counterfactual monthly predicted prevalence of noncompliance ($\sum p_i/N$). Separate models that controlled for potential confounders were run to estimate the pre- to post-decal change in noncompliance with nighttime and passenger restrictions. Analyses were conducted in 2016-2017 using SAS Version 9.3. The study was reviewed and approved by the Children's Hospital of Philadelphia's Institutional Review Board.

RESULTS

We identified 20,593 non-responsible 17- to 20-year-old intermediate drivers in 20,341 unique crashes; 11,252 (55%) occurred in the pre-decal period and 9,341 (45%) occurred in the post-decal period (Table 1). In general, compliance with GDL restrictions was high among all groups. The prevalence of noncompliance over the entire study period was 1.7% (95% Confidence Interval [CI]: 1.6%, 1.9%) for the nighttime restriction and 8.5% (95% CI: 8.1%, 8.9%) for the passenger restriction. Noncompliance with the nighttime restriction increased with age.

Noncompliance with both restrictions was higher during the summer and amongst drivers in areas of lower household income and higher population density (Table 1).

There was no change observed from the pre- to post-decal period in the crude prevalence of noncompliance with either the nighttime (1.75% vs. 1.71%, respectively; $p=0.83$) or passenger (8.68% vs. 8.31%, respectively; $p=0.35$) restriction (Table 1). Generally, within each driver subgroup, compliance did not differ across the time periods (Table 1). After adjusting for age, sex, season, and neighborhood income and population density, there was no significant difference in the prevalence of noncompliance with the passenger restriction from the pre- to post-decal period, with a monthly decrease of -0.15% (95% CI: -1.04%, 0.75%) before implementation of the requirement and a decrease of -0.35% after (95% CI: -1.33%, 0.65%) (p -value for interaction term=0.77). There was also no significant difference in the prevalence of noncompliance with the nighttime restriction from the pre to post-decal period; noncompliance decreased at a rate of -1.67% (95% CI: -3.72%, 0.42%) before and increased at a rate of 0.38% (95% CI: -1.86%, 2.67%) after implementation (p -value for interaction term=0.18). As seen in Figure 2, the adjusted, predicted noncompliance rates in the post-decal period are similar to what would have been predicted in the absence of the decal provision.

Overall 1.7% (95% CI: 1.5 %, 1.9%) of all intermediate drivers' trips occurred during 11:01pm—11:59pm. The proportion of all trips that occurred within the 11 o'clock hour decreased from 2.0% (95% CI: 1.7%, 2.2%) in the pre-decal period to 1.4% (95% CI: 1.2%, 1.7%) in the post-decal period ($\chi^2=9.06$, $p=0.01$). After adjusting for confounders, the proportion decreased an estimated rate of 1.1% per month (95% CI: -3.0%, 0.9%) in the

pre-decal period and an estimated rate of 2.5% per month in the post-decal period (95% CI: -4.9%, 0.0%) (p-value for interaction = 0.37).

DISCUSSION

This study analyzed administrative driver licensing and crash data to evaluate whether young, intermediate drivers were more likely to comply with GDL restrictions after a 2010 decal provision was introduced in NJ—the first such provision in the US. Our results indicate that compliance with both nighttime and passenger restrictions remained high throughout the study period, and that there was no evidence to suggest that compliance appreciably changed from the two-year pre-decal period to the two-year period following implementation.

Our previous evaluation of NJ's decal provision found that overall crash rates among young intermediate drivers decreased 9.5% in the two years after implementation.^{10,13} Police enforcement—measured by per-driver rates of citations that were issued for violating GDL provisions—also increased but was primarily limited to the first year after the provision.^{10,13} Although improved compliance with GDL provisions is one of the primary mechanisms by which decal provisions are hypothesized to lead to crash reduction (see Figure 1),⁸ the findings of this study suggest that the association between NJ's decal provision and reduction in crashes was not mediated by an increase in intermediate drivers' compliance with nighttime and passenger restrictions. Notably, compliance rates even in the pre-decal period were very high, and were remarkably similar to those estimated via naturalistic driving techniques in North Carolina⁷ and Virginia,²⁵ two states that do not currently have a decal provision. The lack of an increase in compliance with GDL provisions reported in this study is consistent with McCartt et al.'s pre-post decal survey.¹² The findings are also consistent with a recent study that found formal deterrence (i.e. police enforcement) was not a significant predictor of self-reported compliance with road rules.²⁶ Collectively, these findings call into question the need for and potential benefit of introducing decal provisions as a means to further increase already-high rates of compliance with nighttime and passenger restrictions.

However, it is important to consider alternative pathways by which NJ's decal provision may have led to observed crash reductions (see Figure 1). Although there were short-term increases in enforcement of GDL provisions, long-term changes in enforcement were not observed.¹⁰ Increased young driver compliance with other traffic safety laws (e.g., speed limits) was possible, but would be difficult to measure given that the number of traffic citations issued is highly dependent on the size of the police force, which likely declined during the economic recession that occurred during the study period. Surveys in NJ and Australia suggest that decal provisions may encourage intermediate drivers to exhibit safer driving behaviors, as one-third to one-half of surveyed teens with intermediate licenses reported that they drove more carefully when displaying their provisional plates or decals.^{12,27} Although only an estimated 40% of intermediate drivers report “always” displaying their decals, it is possible that implementation of the provision encouraged young intermediate drivers to exhibit safer driving behaviors even among those not displaying decals, so as to avoid being cited for decal nonuse.^{12,28} Finally, other drivers may exercise

greater caution or less aggressive driving in the presence of drivers with decals. Intermediate drivers and their parents have previously reported that the identification of novice drivers to other drivers on the road is both a potential benefit and drawback of decal provisions, but the impact of the decals on other drivers' behaviors has yet to be explored.¹² The primary strength of this study is the novel use of the QIE technique, which unlike previous surveys have provided a novel method to evaluate changes in GDL compliance at the population level. One limitation of the study is that there were changes in NJ's passenger and nighttime restrictions introduced at the same time as the decal provision. To address this, we applied the same definition of compliance before and after the new regulations took effect. However, as siblings were exempt from passenger limits in the pre-decal period, it is likely that our estimated noncompliance with passenger restrictions in the pre-decal period overestimated true noncompliance; meanwhile, a lowering of the start time for the nighttime driving restriction in the post-decal period means that estimated noncompliance in the post-decal period is likely an underestimate of the true post-decal noncompliance rate. Both instances of potential misclassification bias would be expected to result in a true noncompliance in the post-decal period that is even higher relative to the pre-decal period than we estimated in this study. Notably, we did observe a reduction in driving exposure during the 11 o'clock hour from the pre-to post-decal period. This change is likely due to intermediate drivers complying with the new restricted hours and not a direct effect of the decal provision; this finding is consistent with the intended effects of the lowered limit via exposure reduction and with the pre-to-post decline in intermediate driver crash rates during the 11 o'clock hour that we observed in our previous paper.¹³ However, we do not expect this time change to have had a large impact on compliance during the midnight to 4:59 a.m. period given that this period was restricted both before and after the provision. In addition, by adjusting for age, sex, season, and neighborhood factors, we believe that we have accounted for differences in distribution of confounding factors that may have occurred between the pre- and post- decal periods; however, it is possible that unobserved, unknown, or hard-to-measure confounders may influence our results. Finally, New Jersey is unique in that it is one of only two US states for which GDL passenger and nighttime restrictions apply to all newly licensed drivers under age 21; in virtually all others, newly licensed drivers aged 18 or older are not subject to these restrictions. New Jersey is also a highly urbanized state and has the highest age of licensure so generalizability to more rural jurisdictions and those with lower licensing ages may be limited.

CONCLUSION

This study is the first to evaluate the effect of a decal provision on compliance with GDL restrictions using objective data. The lack of change in noncompliance rates before and after the decal provision suggests that the decal requirement does not impact compliance with nighttime and passenger restrictions as originally hypothesized. There are other potential mechanisms through which decals may influence novice young drivers' crash rates, and additional studies exploring these mechanisms are needed to understand the role that decal provisions may have in reducing the burden of young driver crashes. Jurisdictions that are working toward implementing decal provisions should carefully consider—given the

characteristics of their young driver population and current GDL policy—their intended outcomes and the pathways by which decals may affect those outcomes.

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References

- Centers for Disease Control and Prevention (CDC). Web-based Injury Statistics Query and Reporting System (WISQARS). National Center for Injury Prevention and Control, Centers for Disease Control and Prevention; <https://www.cdc.gov/injury/wisqars/index.html>. Published 2014. Accessed December 1, 2016
- Williams AF, Tefft BC, Grabowski JG. Graduated Driver Licensing Research, 2010–Present. *J Safety Res.* 2012; 43(3):195–203. DOI: 10.1016/j.jsr.2012.07.004. [PubMed: 22974685]
- Fell JC, Jones K, Romano E, Voas R. An evaluation of graduated driver licensing effects on fatal crash involvements of young drivers in the United States. *Traffic Inj Prev.* 2011; 12(5):423–431. DOI: 10.1080/15389588.2011.588296. [PubMed: 21972851]
- McCartt AT, Teoh ER, Fields M, Braitman KA, Hellinga LA. Graduated licensing laws and fatal crashes of teenage drivers: a national study. *Traffic Inj Prev.* 2010; 11(3):240–248. [PubMed: 20544567]
- Masten SV, Foss RD, Marshall SW. Graduated driver licensing program component calibrations and their association with fatal crash involvement. *Accid Anal Prev.* 2013; 57:105–113. DOI: 10.1016/j.aap.2013.04.013 [PubMed: 23672925]
- Steenbergen LC, Kidd PS, Pollack S, McCoy C, Pigman JG, Agent KR. Kentucky's graduated driver licensing program for young drivers: barriers to effective local implementation. *Inj Prev.* 2001; 7(4):286–291. DOI: 10.1136/ip.7.4.286 [PubMed: 11770653]
- Goodwin AH, Foss RD. Graduated driver licensing restrictions: Awareness compliance, and enforcement in North Carolina. *J Safety Res.* 2004; 35(4):367–374. DOI: 10.1016/j.jsr.2004.04.003 [PubMed: 15474541]
- Senserrick, TM., Haworth, N. Review of Literature Regarding National and International Young Driver Training, Licensing and Regulatory Systems. Victoria, Australia: Monash University Accident Research Centre; 2005.
- New Jersey Teen Driver Study Commission. Teen Driver Study Commission Recommendation Report. Trenton, NJ: 2008.
- Curry AE, Pfeiffer MR, Localio R, Durbin DR. Graduated driver licensing decal law: Effect on young probationary drivers. *Am J Prev Med.* 2013; 44(1):1–7. DOI: 10.1016/j.amepre.2012.09.041 [PubMed: 23253643]
- Curry AE, Pfeiffer MR, Elliott MR. Validation of quasi-induced exposure representativeness assumption among young drivers. *Traffic Inj Prev.* 2015; 17(4):346–351. DOI: 10.1080/15389588.2015.1091072 [PubMed: 26376230]
- McCartt AT, Oesch NJ, Williams AF, Powell TC. New Jersey's license plate decal requirement for graduated driver licenses: attitudes of parents and teenagers, observed decal use, and citations for teenage driving violations. *Traffic Inj Prev.* 2013; 14(3):244–258. DOI: 10.1080/15389588.2012.701786 [PubMed: 23441942]

13. Curry AE, Elliott MR, Pfeiffer MR, Kim KH, Durbin DR. Long-term changes in crash rates after introduction of a graduated driver licensing decal provision. *Am J Prev Med*. 2015; 48(2):121–127. DOI: 10.1016/j.amepre.2014.08.024 [PubMed: 25376478]
14. Curry AE. Estimating Young Novice Drivers' Compliance with Graduated Driver Licensing Restrictions: A Novel Approach. *Traffic Inj Prev*. 2016; 18(1):35–40. DOI: 10.1080/15389588.2016.1171857 [PubMed: 27064815]
15. Curry AE, Pfeiffer MR, Durbin DR, Elliott MR. Young driver crash rates by licensing age, driving experience, and license phase. *Accid Anal Prev*. 2015; 80:243–250. DOI: 10.1016/j.aap.2015.04.019 [PubMed: 25939133]
16. Lyles RW, Stamatiadis P, Lighthizer DR. Quasi-induced exposure revisited. *Accid Anal Prev*. 1991; 23(4):275–285. [PubMed: 1883467]
17. Stamatiadis N, Deacon JA. Quasi-induced exposure: Methodology and insight. *Accid Anal Prev*. 1997; 29(1):37–52. [PubMed: 9110039]
18. Curry AE, Pfeiffer MR, Myers RK, Durbin DR, Elliott MR. Statistical implications of using moving violations to determine crash responsibility in young driver crashes. *Accid Anal Prev*. 2014; 65:28–35. DOI: 10.1016/j.aap.2013.12.006 [PubMed: 24398139]
19. Curry AE, Pfeiffer MR, Elliott MR. Compliance with and enforcement of graduated driver licensing restrictions. *Am J Prev Med*. 2017; 52(1):47–54. [PubMed: 27746012]
20. Curry AE, Pfeiffer MR, Durbin DR, Elliott MR, Kim KH. Young driver licensing: examination of population-level rates using New Jersey's state licensing database. *Accid Anal Prev*. 2015; 76:49–56. DOI: 10.1016/j.aap.2014.12.022 [PubMed: 25590921]
21. United States Census Bureau. 2007–2011 American Community Survey 5-year estimates. ACS Demographic and housing estimates. 2011. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP05&prodType=table. Published 2011. Accessed February 1, 2014
22. United States Census Bureau. Census Gazetteer Files. 2010. <https://www.census.gov/geo/maps-data/data/gazetteer2010.html>. Published 2010. Accessed February 1, 2014
23. Skov T, Deddens J, Petersen MR, Endahl L. Prevalence proportion ratios: Estimation and hypothesis testing. *Int J Epidemiol*. 1998; 27(1):91–95. DOI: 10.1093/ije/27.1.91 [PubMed: 9563700]
24. Petersen MR, Deddens JA. A comparison of two methods for estimating prevalence ratios. *BMC Med Res Methodol*. 2008; 8(1):9.doi: 10.1186/1471-2288-8-9 [PubMed: 18307814]
25. Klauer SG, Simons-Morton B, Lee SE, Ouimet MC, Howard EH, Dingus TA. Novice Drivers' Exposure to Known Risk Factors During the First 18 Months of Licensure: The Effect of Vehicle Ownership. *Traffic Inj Prev*. 2011; 12(2):159–168. DOI: 10.1080/15389588.2010.549531. [PubMed: 21469023]
26. Allen S, Murphy K, Bates L. What drives compliance? The effect of deterrence and shame emotions on young drivers' compliance with road laws. *Polic Soc*. 2015; :1–15. DOI: 10.1080/10439463.2015.1115502
27. Bates L, Scott-Parker B, Darvell M, Watson B. Provisional drivers' perceptions of the impact of displaying P plates. *Traffic Inj Prev*. 2017; doi: 10.1080/15389588.2017.1322697
28. Williams AF, McCartt AT. Views of New Jersey teenagers about their state's policies for beginning drivers. *J Safety Res*. 2014; 48:1–6. DOI: 10.1016/j.jsr.2013.10.001 [PubMed: 24529085]

Implications and Contributions

This study evaluates the effect of a decal provision on compliance with GDL restrictions using objective data. Compliance rates with nighttime and passenger restrictions remained high and unchanged after the provision, suggesting that compliance was not the mechanism through which the decal requirement reduced crash rates.

Figure 1.
Hypothesized Causal Pathway from Decal Provision to Crash Reduction (evaluated mechanism highlighted)

Figure 2. Monthly Observed and Predicted Prevalence of Noncompliance with Passenger and Nighttime Restrictions, New Jersey, May 2008–April 2012

Table 1

Prevalence of noncompliance with nighttime^a and passenger^b restrictions among non-responsible crash-involved intermediate drivers (N=20,593), New Jersey, May 2008–April 2012

Variable and values	Nighttime Driving Restrictions ^b				Passenger Restrictions ^c			
	Pre-Dec al N	Post-Dec al N	Pre-Decal %	Post-Decal %	p-val (change in %)	Pre-Decal %	Post-Decal %	p-val (change in %)
<i>Overall</i>	11252	9341	1.75	1.71	0.83	8.68	8.31	0.35
Age								
17	5095	4529	0.73	0.58	0.36	8.22	7.59	0.25
18	2887	2482	2.26	1.99	0.49	9.67	9.76	0.92
19	1840	1308	2.57	3.93	0.03	8.53	9.12	0.57
20	1430	1022	3.31	3.26	0.95	8.52	7.02	0.18
Sex								
Female	6112	4889	1.49	1.38	0.61	8.15	8.30	0.78
Male	5140	4452	2.05	2.08	0.94	9.31	8.33	0.09
Season								
Spring: Mar–May	3024	2383	1.76	1.39	0.29	8.72	8.63	0.91
Summer: Jun–Aug	2705	2232	2.16	1.80	0.37	9.55	9.57	0.98
Fall: Sept–Nov	2908	2577	1.89	1.91	0.97	8.29	7.90	0.60
Winter: Dec–Feb	2615	2149	1.16	1.73	0.09	8.16	7.15	0.19
School Year								
School: Sep–Jun	9574	7963	1.64	1.68	0.82	8.69	7.81	0.04
Summer Break: Jul–Aug	1678	1378	2.40	1.89	0.34	8.64	11.20	0.02
Median Household Income Quintile (N=20,410)								
Q1 (\$57,226)	2323	1851	3.59	3.56	0.95	11.57	10.79	0.43
Q2 (\$57,226–\$72,857)	2378	1972	1.35	1.78	0.25	8.57	7.94	0.45
Q3 (\$72,858–87,222)	2277	1836	1.45	1.04	0.24	8.06	8.57	0.56
Q4 (\$87,223–\$105,888)	2377	2050	1.18	1.08	0.74	7.75	8.12	0.66
Q5 (\$105,889)	1739	1607	0.87	1.12	0.45	7.09	6.04	0.22
Population Density Quintile (N=20,411)								
Q1 (408.6)	877	659	1.26	0.91	0.52	6.30	9.92	0.01

Variable and values	Nighttime Driving Restrictions ^b				Passenger Restrictions ^c		
	Pre-Dec al N	Post-Dec al N	Pre-Decal %	Post-Decal %	Pre-Decal %	Post-Decal %	p-val (change in %)
Q2 (408.7–1223.6)	2144	1896	0.84	0.95	6.98	7.61	0.44
Q3 (1223.7–2615.8)	2739	2245	1.43	1.25	8.95	7.41	0.05
Q4 (2615.9–4876.8)	2771	2391	1.74	1.18	8.09	8.43	0.66
Q5 (4876.9)	2564	2125	2.95	3.77	11.28	9.38	0.03

^a Definition of nighttime restriction used in both the pre- and post-decal period was midnight through 4:59am

^b Definition of passenger restriction used in both the pre- and post-decal period was presence of more than one passenger when no passenger was aged 35 or older

^c Information on nighttime driving restriction compliance was missing for 101 drivers

^d Information on passenger restriction compliance was missing for 74 drivers