Evaluation of a Program to Enhance Young Drivers' Safety in Israel

Tomer Toledo*

Technion – Israel Institute of Technology, Haifa, Israel

Tsippy Lotan

Or Yarok, Hod Hasharon, Israel

Orit Taubman - Ben-Ari

Bar-Ilan University, Ramat Gan, Israel

Einat Grimberg

Or Yarok, Hod Hasharon, Israel

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* Corresponding author, Transportation Research Institute, Technion – Israel Institute of Technology, Haifa 32000, Israel. Fax: 972-4-8295708, Email: toledo@technion.ac.il

ABSTRACT

Young drivers in Israel, as in other parts of the world, are involved in car crashes more than any other age group. The graduated driver licensing system in Israel requires that all new drivers be accompanied by an experienced driver whenever they drive for the first three months after obtaining a driving license. In an effort to make the accompanied driving phase more effective, a novel program which targets both young drivers and their parents was initiated in 2005. The program administers a personal meeting with the young driver and the accompanying parent scheduled for the beginning of the accompanied driving phase. In this meeting guidance is given regarding best practices for undertaking the accompanied driving, as well as tips for dealing with in-vehicle parent-teen dynamics. Through 2008, almost 130,000 families of young drivers have participated in the program.

In order to evaluate the effectiveness of the program, injury crash records of the young drivers who participated in the program were compared with those of all other young drivers that were licensed at the same time period. The results obtained indicate statistically significant lower crash records for young drivers that participated in the program. Limitations of the evaluation related to self-selection biases are discussed, and practical implications are suggested.

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1. INTRODUCTION

Young drivers worldwide are involved in car crashes more than any other age group, even after controlling for number of drivers, miles traveled and population size (e.g., Lotan and Toledo, 2007; Williams, 2003). Research shows that the first year of licensure is the most risky, with the initial months of independent driving recording highly elevated crash rates. These rates rapidly decline after approximately six months, and continue to decline more slowly during the following years (Simons-Morton, 2007). Several authors relate these statistics to the lower driving competence of young novice drivers, who are still in the learning process, and whose exposure to various road conditions is relatively low (e.g., Mayhew et al., 2003; Simons- Morton, 2007).

This phenomenon has received significant media and political attention and prompted various regulatory changes that affected the driver licensing system. Many jurisdictions have implemented Graduated Driver Licensing (GDL) systems, in which young drivers undergo several stages of learning, gaining experience, and being gradually exposed to more risky driving environments. Most GDL programs consist of three phases: learner permit, provisional license, and full license. The learner permit allows holders to drive only when accompanied by an experienced driver. The provisional license sets certain restrictions on the novice drivers. It often restricts or prohibits nighttime driving and limits the number of passengers allowed in the vehicle. In addition, during this phase the tolerance to traffic violations, in particular speeding and alcohol and drug abuse, is lower and the associated penalties higher (Hedlund, 2007; Hedlund et al., 2006; Williams and Shults, 2007).

Several evaluation studies of various GDL systems attest to its effectiveness. For example, Shope (2007) summarized results of 27 studies, concluding that they consistently show that GDL programs reduce overall crash rates of novice young drivers by 20-40%. Similarly, comparing GDL systems in various American states, Baker et al. (2007) found that the fatal crash rates of 16-year-old drivers were 38% lower and the injury crash rates were 40% lower in the states with the most restrictive GDL programs compared to states that did not implement GDL at all. Vanlaar et al. (2009) conducted meta-analysis of the GDL programs in 58 American and Canadian jurisdictions to evaluate the impact of the various components of these programs. Overall, they found compelling evidence in support of GDL, with emphasize on nighttime driving and passenger restrictions, and on driver education and training.

The GDL effectiveness in reducing the involvement of young and novice drivers in car crashes is mainly attributed to their ability to enable young drivers to gain significant practical driving experience, and, simultaneously, protect them to a large degree from the inherently high crash risk attendant to novice driver status (ECMT, 2006; Foss, 2007). Two groups of factors are generally accepted as the underlying causes: First, GDL reduces the level of exposure to risk, by restricting nighttime driving and the number of passengers; Second, it encourages improved driving knowledge, experience and hazard perception skills through prolonged and more controlled licensure procedures (Hedlund et al., 2003, 2006; Hedlund and Compton, 2004; McKnight and Peck, 2002; Vanlaar et al., 2009).

In Israel, teenagers can begin taking driving lessons (given by professional instructors on specially equipped vehicles) at the age of 16.5, and are permitted to drive only during these lessons. A driving license is issued upon passing a written theory test and an on-road driving test. The on-road test cannot be taken until the learner has turned 17, passed the theory test

and completed a minimum of 28 on-road driving lessons. All new drivers, regardless of age, are required to be accompanied by an experienced driver, someone over the age of 24 who has held a valid driving license for a minimum of five years, for the first three months after licensure. In addition, for a period of two years after licensure, new drivers are also restricted to carrying up to two passengers, unless accompanied by an experienced driver. There are no restrictions on nighttime driving. The transition from the accompanied driving phase (ADP) is defined solely by the passage of time from licensure (Lotan and Toledo, 2007). There are no minimum requirements regarding the number of driving hours during this period. It is also important to note that from a legal point of view, the young driver already possesses a valid driving license during the ADP and so the responsibility lies with the young driver and not the accompanying person. This status is similar to the German system and unlike other European systems that allow layman accompanied driving (Hendrix, 2006).

The injury crash involvement of young Israeli drivers (ages 17 to 24) in the years 2005-2008 that followed the implementation of the current GDL program, as a function of the months of driving experience they have gained is shown in Figure 1. The figure shows that their involvement in injury crashes during the ADP is very low. However, immediately after the end of the ADP, crash involvement increases dramatically. This high crash involvement then gradually decreases. As noted above, similar trends were also observed elsewhere in the world (e.g. Mayhew, 2003; VicRoads, 2005). It has been shown (e.g. McCartt et al., 2003; Mayhew, 2003; McKnight and Peck, 2002) that the driving experience that young drivers gain in the ADP has a tempering effect on the high crash involvement in the period that follows it. However, an important shortcoming of the current GDL system in Israel in this respect is the lack of guidance on the desirable extent and content of accompanied driving. Moreover, although the role of parents has been identified as an important factor affecting the behavior

of young drivers (e.g., Simons-Morton, 2007; Taubman – Ben-Ari, 2010; in press), there had been no programs promoting parental involvement in youth driving in Israel.

These shortcomings motivated Or Yarok (Green Light), the largest non-government organization in Israel dealing with road safety, to design a program titled Green Light for Life (GLL) that aims to improve the quantity and quality of driving that young drivers undertake during the ADP. The GLL program mainly consists of a 45-minute meeting between a representative of Or Yarok, the young driver and his or her parents. The meeting takes place at the family's home as close as possible to the beginning of the ADP. The meeting goals are to explain the objectives and importance of the ADP, bridge gaps between parents and young drivers regarding their expectations from the ADP, and enhance parents' willingness and ability to share their experience and hazard perception skills with the young driver. The program is publicized through media campaigns, the internet, lectures in schools and a bring-a-friend mechanism. Teenagers are also contacted by phone during their learning phase, informed about GLL and are offered to schedule a meeting. For more details on the program, see Taubman – Ben-Ari and Lotan (2011).

The GLL program was launched as a pilot in January 2004, and has been implemented since January 2005 nationwide. Table 1 presents levels of participation in the program from 2005 to 2008. Although participation in the program is voluntary, it achieved high penetration rates of over 40%. Almost 130,000 young drivers participated in the program in these four years.

To date, only one study (Taubman – Ben-Ari and Lotan, 2011) has evaluated the effectiveness of this program, by comparing between a sample of 362 young drivers who participated in the program and 376 young drivers who did not participate in it. The study utilized quantitative

measures through self-report questionnaires attained by a telephone survey. Measures included attitudes towards the ADP, driving experience gained in the ADP, driving without an accompanying driver during the ADP, risk evaluation, frequency of committing traffic violations, and involvement in car crashes. The results showed no differences between the two groups in the amount of driving practice during the ADP and in the reported reckless driving. However, GLL participants showed more positive views regarding the ADP and were less involved in car crashes.

Though this evaluation study was comprehensive and consisted on a large sample, it nevertheless relied on self-report measures of attitudes, perceptions, and behavior of the novice drivers, rather than on actual safety outcome observations. In order to strengthen the validity of the results, the present study sought to evaluate the effectiveness of the GLL program by comparing the nation-wide statistics of injury crash involvement in the initial two years after licensing of the population of young drivers who participated in the program with those of the drivers that did not participate.

2. METHODS

2.1. Data

The data on the injury crash involvement of the GLL participant and non-participant populations was derived from three separate databases: (1) Records of all participants in the GLL program in the period from January 2005 to January 2007, (2) Records of all young new drivers in Israel for the same period, and (3) Records of all drivers who were involved in injury crashes that were reported to the police from January 2005 to December 2008. It should also be noted that two groups in the Israeli population, Ultra-Orthodox Jews and Arabs, do not generally participate in the GLL program. Together they make up over 20% of the young

drivers population. These groups have different cultural, socio-demographic and crash involvement characteristics and so specific programs are tailored to young drivers in these groups. The results reported in this paper do not include novice drivers in these groups.

The records in the three databases were matched using the drivers' unique national identification numbers. However, due to privacy regulations, licensure and crash records of individual drivers could not be obtained and so only aggregate statistics based on the month of licensure were calculated. These statistics were calculated for two groups in the population: participants in the GLL project (77% of which were matched in the licensure records) and young drivers that were eligible to participate in the project but did not.

2.2. Statistical analyses

First, the overall differences in injury crash involvement among GLL participants and non-participants were evaluated using a series of t-tests for the continuous crash rate variables during the periods covered in the data. These tests are built on the assumption that the number of injury crashes for a group of drivers is a binomial random variable.

Next, in order to quantify the impact of the GLL, taking into account the dependency on the GDL stages and the months of driving experience that the novice young drivers have accumulated, a model that predicts the number of injury crashes in each month for groups of drivers (based on the month they received their license and whether or not they participated in the GLL program) was developed. The following Poisson regression form was used:

$$\ln\left(IC_{itn}\right) = -\ln\left(10000\right) + \ln\left(N_{in}\right) + \ln\left(D_{t}\right) + X_{itn}\beta + \varepsilon_{it} \qquad (1)$$

Where IC_{itn} is the number of injury crashes during month *t* for drivers in group *n* (two groups are defined: GLL participants or non-participants) that received their licenses during month *i*. X_{itn} is a vector of explanatory variables, β is the corresponding vector of parameter. ε_{it} is an error term. N_{in} and D_t are the number of drivers in group *n* that were licensed during month *i* and the number of days in month *t*, respectively. These values, together with the constant 10,000 are used as offsets to normalize the number of accidents per 10,000 drivers per day.

The data for estimation of this model includes 1200 observations (GLL participants and non-participants, 25 licensing months cohorts, 24 observation months). The number of drivers in these groups ranges from 744 to 5535.

3. RESULTS

3.1. Differences between GLL participants and non-participants

Table 2 summarizes the involvement in injury crashes of GLL participants and non-participants. Overall the crash rates of GLL participants are lower compared to non-participants by 12.7%. The differences in crash rates are statistically significant at the 95% confidence level or better for the full dataset and for segments defined by the licensing year.

Estimation results for the injury crash participation model are presented in Table 3. All variables in the model are significant at 95% or better confidence levels. The variable of interest for the evaluation of the GLL program is the participation dummy. This variable takes the value 1 for the participant group and 0 for non-participants. The parameter value of this variable is negative in the model. This value implies that participants in the GLL program have a lower crash involvement rate compared to non-participants in the first 24 months after licensure by 11.2%. Another variable that captures the additional impact of the participation in the GLL program in the initial two months after licensure is also used. The coefficient of

this variable is positive indicating that in these months, the injury crash involvement of GLL participants is higher by 31.3% than that of non-participants. It should be noted that, as other variables in the model will indicate, injury crash rates in these two months are very low in any case, and so the magnitude of this increase in terms of expected crash rates is small.

The ADP dummy variable takes a value 1 during the three months of the ADP and 0 after the ADP is completed. The parameter value is large and negative, which indicates that injury crash rates are significantly lower during ADP. The last group of variables in the model relates to the level of experience drivers have gained. These variables take the value 1 for drivers that have a specific level of experience and 0 otherwise. Their parameter estimates indicate that crash risks are highest immediately after the completion of the ADP, in months 3-6 after licensure, and decrease gradually after that. The combined effect of the ADP and the experience level on the injury crash rates is demonstrated in Figure 2, which shows predicted crash rates for GLL participants and for non-participants.

Finally, we note that seasonality effects and the impacts of the licensure month i and the accident month t were tested but did not have significant impacts and so were omitted from the final model. Several interaction variables that were tested were also not significant in the model. These variables included allowing for the impact of experience to differ between GLL participants and non-participants, for differences between GLL participants in the pilot stage of the project and the nationwide coverage period, and for differences in the injury crash rates of young drivers that experienced two or three months ADP.

3.2. Addressing potential selection bias

The results presented above indicate that young drivers that participated in the GLL program are over 10% less likely to be involved in injury crashes compared to those that did not.

However, as mentioned above, participation in the program is voluntary. Therefore, the results may be subject to selection bias if the young drivers that choose to participate in the program have different characteristics compared to those that do not. We attempt to address this issue in two ways: first, we repeat results reported by Taubman – Ben-Ari and Lotan (2011) who used a sample of self-reports to evaluate differences in attitudes and behavior between the two groups. Secondly, we evaluate differences in socio-demographic characteristics, namely age and gender, between the two groups, as potential indicators to underlying selection biases.

In a related study that was described above, Taubman – Ben Ari and Lotan (2011) conducted analysis of self-reports of a sample of 738 GLL participants and non-participants. Their results are reproduced in Table 4. The table shows only small and statistically insignificant differences between the two groups in the fraction of drivers that violated the accompanied driving regulation and in three measures related to risky behavior: own frequency of undertaking various behaviors (e.g. running red lights, not stopping at stop signs), popularity of these behaviors among friends, and the perception of the risk associated with them. This similarity in risk attitudes and behaviors does not seem to support the existence of substantial selection bias related to these characteristics. Similar to the results reported here, GLL participants also reported to be less involved in car crashes than non-participants. There was no statistically significant difference in the amount of driving experience the drivers in the two groups have gained during the ADP, However, GLL participants perceived the ADP as more effective compared to non-participants. These results seem to suggest that at least in the perception of the young drivers, the activities of the ADP are a contributing factor to improved safety. .

In order to further assess the potential bias, we also examined the GLL participant and non-participant populations on two characteristics that have been shown to affect car crash rates: gender and age at licensure. For that purpose, the two groups of drivers (GLL participants and non-participants) were stratified based on age and gender. Table 4 shows the fractions of drivers and their injury crash rates in each of these strata for the two groups. The crash rates are normalized by the crash rates of 17 years-old males in the non-participants group, who have the highest crash rates. Therefore, the normalized crash rates take values between 0 and 1. Table 4 shows that there are differences between the two groups that may be contributing to the differences in injury crash rates. Across all ages, 55.4% of non-participants are males, whereas only 53.2% of GLL participants are males. The crash rates for male drivers are roughly double those of female drivers, and so the slight under-representation of males in the GLL program may be biasing the crash rates of this group downwards. In contrast, GLL participants tend to be younger compared to non-participants (84.6% of participants but only 66.7% of non-participants are 17 or 18 years old). This difference is expected given that some of the GLL recruitment efforts take place in schools and related activities. Injury crash rates are highest for drivers that are licensed at the age of 17. They then decrease with the licensure age, but increase again for drivers that are licensed at ages 22-24 (however, these drivers constitute a very small fraction of new young drivers). Therefore, the different age distribution of GLL participants may be biasing crash rates of this group upwards compared to non-participants.

A correction factor to the crash rates was estimated in order to evaluate the magnitude of the bias caused by the difference in socio-demographic characteristics between the two groups. The correction factor is calculated as the ratio of expected crash rates for the non-participants

group under the gender and licensure age distribution of GLL participants to their observed crash rates:

$$CF = \frac{\sum_s f_s^P CR_s^{NP}}{\sum_s f_s^{NP} CR_s^{NP}} \quad (2)$$

Where CF is the correction factor. f_s^P and f_s^{NP} are the fractions of drivers in strata s (defined by gender and licensure age) in the GLL participants and non-participants groups, respectively. CR_s^{NP} is the normalized crash rate for non-participants drivers in strata *s*.

The correction value calculated for the joint distribution of gender and licensure age is 1.053. This value implies that the difference in crash rates between the two groups would be even higher than predicted by the model (11.8% instead of 11.2%) if the socio-demographic characteristics of GLL participants were similar to those of non-participants. If only the difference in the gender distribution, which favors the GLL participants group, is accounted for, the estimated correction factor is 0.987. In this case, the crash rate for GLL participants is 11.0% lower compared to non-participants. Thus, even after accounting for gender and licensure age characteristics of the two groups, GLL participants are less likely to be involved in injury crashes compared to non-participants.

4. CONCLUSION

The current study presents results regarding the differences between participants and non-participants in the GLL program with respect to crash rates among young new drivers. In contrast to common assessments of interventions, findings are not based on convenience or even representative samples, but on injury crash records of the population of Israeli young

drivers who participated in the program in comparison to all new young drivers that were licensed at the same period and did not participate in the program. Descriptive statistics comparing injury crash records of those who participated in the GLL program to those who did not reveal a significant difference in favor of those who participated. Analysis based on a Poisson regression model indicates that participation in the program is associated with over 10% lower rates of involvement in injury crashes of young drivers in the first 24 months after licensure. These lower crash rates are statistically significant and maintained even after correcting for potential self-selection bias that may result from the different characteristics of young drivers that choose to participate in the program compared to those that do not. It is important to note that these corrections may not fully account for the potential for selection bias due to differences in attitudes towards driving and safety between the two groups. In a follow up study we are collecting data on the behavior and crash records at the individual level, which may assist in further addressing selection bias.

The current results are in line with those of a previous study, based on a sample of GLL participants and non-participants, which similarly showed self-reported crash involvement to be lower among participants (Taubman – Ben-Ari and Lotan, 2011). Importantly, this previous study may provide a hint to help interpret current results. Specifically, it showed that participants were similar to non-participants in reports on driving experience gained in the ADP, driving without an accompanying driver during the ADP, risk evaluation, and frequency of committing traffic violations. However, differences between the two groups were found in regard to attitudes towards the ADP and involvement in car crashes - GLL participants showed more positive views regarding the ADP and were less involved in car crashes. Taken together with the present findings, it might be suggested that the GLL increases awareness and recognition in the importance of the ADP, which might augment the

utility of this period in reducing involvement in crashes. In this stage of the investigation, this should be taken with a degree of caution as no casual pattern has been proved.

Beyond the results on the differences between the crash rates of the two groups, the current findings also attest to two important issues. Firstly, analysis of injury crash data of young drivers during the first months after licensure reveals a clear pattern of low crash involvement during the ADP, a sharp peak of crashes immediately after the end of the ADP and the beginning of the solo driving, and a gradual decrease afterwards. Hence the ADP should be regarded as an vital opportunity to help and motivate young drivers to become better and safer drivers. Secondly, the role of parents in the safety measures of young drivers cannot be underestimated. Joining a host of previous studies (e.g., Simons-Morton, 2007; Taubman – Ben-Ari, 2010; in press), the current study indicates that programs which are based on communal efforts of young drivers and their parents, may lead the way to a change in the driving culture of our society.

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Table 1:

Participation in the GLL program by licensing year

Year	**Number of eligible young drivers**	**Number of participating families**	**Market penetration (%)**
2005	82,796	22,759	27.5
2006	78,929	33,443	42.4
2007	76,114	41,331	54.3
2008	84,111	32,259	38.4
Total	321,950	129,972	40.4

Table 2:

Injury crash statistics for GLL participants and for non-participants

Period	Statistic	Participants	Non-participants
2005	Sample size	17,087	46,945
	Injury car crashes	443	1,363
	Injury crash rate (per 10,000 drivers)	259.3	290.3
	Difference	-31.1 (-10.7%)	
	p-value	0.031	
2006 + January 2007	Sample size	27,367	39,166
	Injury car crashes	650	1,063
	Injury crash rate (per 10,000 drivers)	237.5	271.4
	Difference	-33.9 (-12.5%)	
	p-value	0.006	
Total	Sample size	44,454	86,111
	Injury car crashes	1,093	2,426
	Injury crash rate (per 10,000 drivers)	245.9	281.7
	Difference	-35.9 (-12.7%)	
	p-value	<0.001	

Table 3:

Estimation results for the injury crash involvement model

Variable	**Parameter Value**	**t-statistic**	**p-value**
Constant	-1.155	-36.0	<0.001
GLL participation dummy	-0.119	-3.06	0.002
GLL participation, 1-2 months experience	0.391	2.04	0.041
ADP dummy	-0.995	-10.8	<0.001
3-6 Months experience dummy	0.738	15.2	<0.001
7-13 Months experience dummy	0.402	9.2	<0.001

Table 4:

Means, standard deviations and p-values for participants and non-participants in the sample

(Source: Taubman - Ben-Ari and Lotan , 2011)

	Participants		**Non-participants**		**p-value**
	Mean	**STD**	**Mean**	**STD**	
Driving experience during ADP	5.75	5.20	5.90	4.94	0.69
Perception of ADP as effective	4.06	0.71	3.85	0.87	<0.001
Percieved popularity of risky driving among friends	1.64	0.45	1.61	0.50	0.54
Riskiness evaluation of traffic violations	3.39	0.42	3.40	0.49	0.68
Reported frequency of risky driving	1.46	0.45	1.44	0.49	0.44
Driving without an accompanying person	21%		20%		0.59

Table 5:

Fractions of drivers and injury crash rates by gender and age at licensure

Strata		**Participants**		**Non-participants**	
Gender	**Age at licensure**	**Fraction** (f_s^P)	**Normalized injury crash rate** (CR_s^P)	**Fraction** (f_s^{NP})	**Normalized injury crash rate** (CR_s^{NP})
Male	17	0.362	0.415	0.282	1.0
	18	0.112	0.379	0.121	0.812
	19	0.024	0.431	0.045	0.816
	20	0.011	0.384	0.027	0.637
	21	0.008	0.455	0.026	0.623
	22	0.009	0.547	0.028	0.642
	23	0.006	0.398	0.020	0.705
	24	0.001	0.558	0.003	0.745
Female	17	0.246	0.233	0.158	0.580
	18	0.126	0.150	0.106	0.440
	19	0.033	0.192	0.047	0.353
	20	0.023	0.283	0.041	0.375
	21	0.021	0.165	0.040	0.330
	22	0.012	0.132	0.029	0.356
	23	0.007	0.268	0.021	0.419
	24	0.001	0.0	0.004	0.436

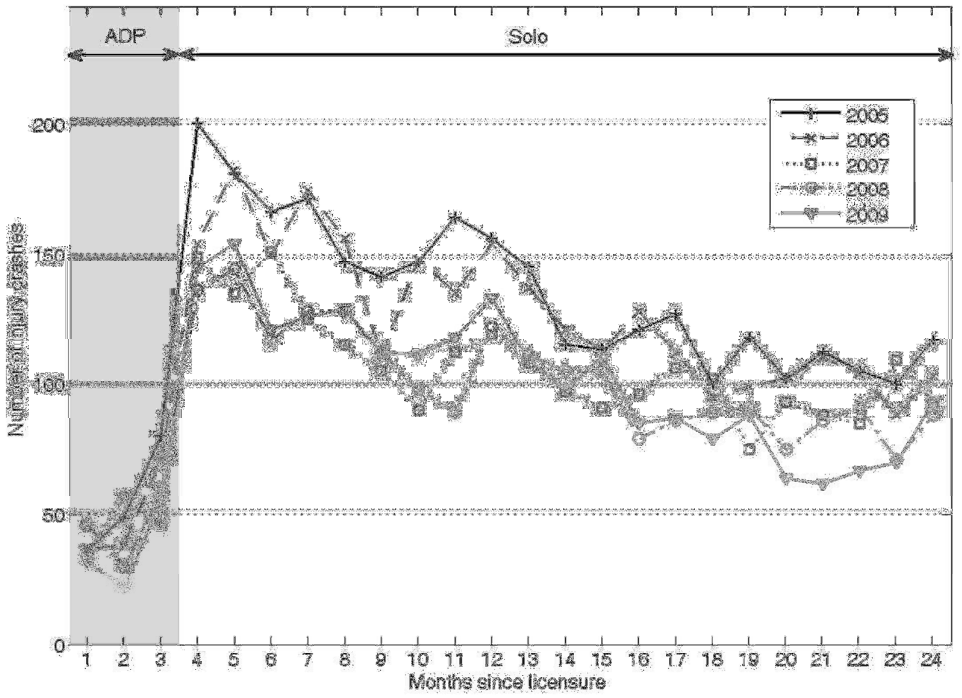

Figure 1:

Injury crash involvement of young drivers in Israel by driving experience

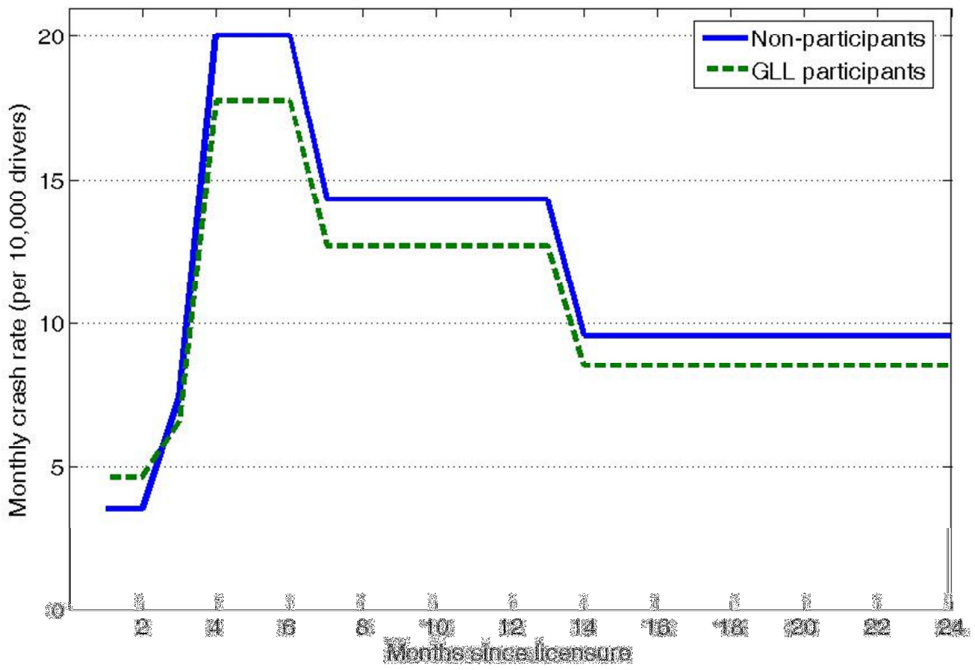

Figure 2:

Predicted injury crash involvement rates for GLL participants and non-participants