Safety Benefits of teenSMART Driver Training

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Prepared by:

Dunlap and Associates, Inc.
Stamford, CT

F. Dennis Thomas, PhD, MA
Jenna Darrah, MS

Abstract

TeenSMART, is a computer-based training program designed to augment traditional classroom and on-road driver training by covering higher order cognitive skills that research suggests are related to teen driver safety. This study examined whether young drivers completing the TeenSMART program demonstrated a reduction in traffic violations and/or crashes relative to a comparison group of similar teens involved in a prior study who did not complete the program. Overall, TeenSMART-trained drivers (N = 9119) had an approximately 54% lower traffic violation rate than the comparison group ($p < .001$). The results regarding crashes were also suggestive of a safety effect from TeenSMART but were somewhat dependent on the referral source (e.g., insurance company) of the TeenSMART participants. Approximately half of the TeenSMART sample (N = 4379) that came from multiple referral sources showed a 31% lower property damage only crash rate relative to the comparison group ($p < .01$). The same group of participants also showed a 16% lower injury crash rate but the difference, while fairly large, was not statistically significant ($p > .05$). Crash data for TeenSMART participants from the second group (N = 4740) representing the other half of the sample were analyzed separately and showed no statistically significant differences for property damage only or injury crashes relative to the comparison group (ps > .05). Taken as a whole, the findings of this study are suggestive of a conclusion that TeenSMART improves young driver safety. The traffic violation reductions are compelling, and the reductions in crashes are promising. The premium reductions allowed by various state insurance boards for completion of TeenSMART also suggest the insurance carriers are providing similar actuarial evidence to support the effectiveness of the program. A program such as TeenSMART can easily be integrated into existing graduated driver license programs and may also be effective as part of *Phase 2 Driver Education* after a young driver has received a first license for unsupervised driving.

Keywords

Teen Driver, Violations, Crashes, Driver Education, Graduated Driver Licensing, GDL, Novice Driver, Training, Safety, Hazard Anticipation, Distracted Driving

Introduction

According to the Insurance Institute for Highway Safety (IIHS; 2019) a total of 2,476 teens in the United States aged 13-19 were killed in motor vehicle crashes in 2018. IIHS (2019) also notes that per mile driven, teen drivers in the 16-19 year-old age group are nearly three times more likely than drivers aged 20 and older to be in a fatal crash. To address the high crash rates of teen drivers, States have enacted Graduated Driver Licensing (GDL) programs that impose a variety of restrictions on when and where young drivers can drive. Research (e.g., McCartt et al., 2010; Masten et al., 2015) suggests that such GDL programs have been effective at reducing young driver crashes, especially for 16 and 17 year-olds.

Driver education is a central component of GDL, but the effectiveness of traditional driver education programs alone at reducing crashes and violations of teen drivers has been questionable. Studies of novice driver education programs have not found a consistent pattern of improved teen driver safety after completion of traditional driver education courses (Thomas, et al., 2012). One recent large-scale study, however, did report that teens who completed driver education had fewer crashes and violations than a group that only learned from and practiced with their parents (Shell et al., 2015). This study, however, suffered from self-selection bias as the teens who did not take driver education had notably different demographics than those who took the formal course.

While it appears traditional driver education does a good job at preparing teens to pass the driver license test (Thomas et al., 2012), it may not be providing adequate coverage of the key factors that actually impact teen driver safety. Examples of these factors as identified by McKnight and McKnight (2003) include inadequate visual scanning, poor attention maintenance, and inappropriate speed management. Research has also shown teen drivers have poor anticipation of the existence and position of unexpected hazards (Pradhan et al., 2005) and do not control the speed, acceleration, and position of their vehicle well (Fisher et al., 2002; Sagberg & Bjørnskau, 2006). It has been suggested (e.g., Mayhew et al., 2016) to add *Phase 2 Driver Education* to GDL to address these higher order cognitive skills that basic driver education tends not to cover.

One study (Thomas et al., 2016) provided some evidence that a brief program focusing on hazard anticipation could reduce crash rates, at least for males. The training program studied, however, was very short (took less than 20 minutes to complete) and only covered the single topic of hazard anticipation. No crash reduction was observed for females, and there was no reduction in traffic violations for those completing the program. Nevertheless, the encouraging results from Thomas et al. (2016) suggest that a more in-depth training program that covers a variety of higher order cognitive skills could potentially have a greater impact on driver safety.

One such program, TeenSMART, is a computer-based driver training program designed to augment traditional classroom and on-road driver training by covering higher order cognitive skills that research suggests are related to teen driver safety. The program includes modules on:

1. Visual Awareness
2. Hazard Recognition

3. Speed and Space
4. Risk Perception
5. Gap Analysis
6. Critical Decision Making
7. Lifestyle Issues and Distracted Driving.

The program also has a number of protections in place (e.g., tests, time monitoring) to ensure the young drivers taking the program are engaged and attending to its materials. Also, the content was determined through epidemiology studies and development evaluations were conducted to document crash avoidance skill growth as a result of training. This study examined whether young drivers completing the TeenSMART program demonstrated a reduction in traffic violations and/or crashes relative to a control group of similar teens who did not complete the program.

Method

Participants. The TeenSMART sample as a whole (N = 9119, 53.24% male) included all 16 to 18 year-olds who successfully completed the training course in California during 2016. Each TeenSMART driver's age was calculated based on the date they completed the course. Participants came from multiple sources (i.e., insurance carriers, driver training schools) that were not specifically identified to researchers due to corporate privacy agreements. No breakdowns of age or sex are provided in this document for individual sources of participants to further protect what is viewed as proprietary information by preventing any inference of the identity of a specific organization.

The comparison group use in statistical analyses was composed of California teen driver participants in the Thomas et al. (2016) study who did not receive any training as part of that study (N = 2562, 53.94% male). These teens were enrolled as the control group in the Thomas et al. (2016) study during 2011 to 2012 immediately after passing the road test to receive an intermediate or unrestricted license (based on their age). As can be seen in Table 1 below, the TeenSMART group as a whole was much larger than the comparison group and included many more 16- and 17-year olds, and a slightly larger number of 18-year olds.

Table 1. Sex And Age

		All TeenSMART		Comparison	
Sex	Age	n	n%	n	n%
Male	16	1663	18.24%	412	16.08%
	17	2393	26.24%	333	13.00%
	18	799	8.76%	637	24.86%
	Subtotal	4855	53.24%	1382	53.94%
Female	16	1599	17.53%	366	14.29%
	17	2022	22.17%	287	11.20%
	18	643	7.05%	527	20.57%
	Subtotal	4264	46.75%	1180	46.06%
Total		9119		2562	

TeenSMART Training (Version 4.2). The training program was computer-based (downloaded to a local personal computer) with modules for each of the topic areas described above. Students completed the modules in the prescribed order. Each module included extensive material on the focus topic including videos from the driver's point of view, interactive computer-based simulations, psychometric assessment of crash avoidance skills and knowledge tests. Parent-teen activities were also included. A final test was passed at the end of the entire program for a certificate of completion to be issued. The computer portion of the program took approximately four hours to complete. Another four to six hours were needed to complete all parent-teen activities including in-car driving sessions. The certificate of completion was generally submitted to an insurance carrier for a discount on monthly premiums.

Crash and Violation Data. Researchers obtained crash and violation data from the California Department of Motor Vehicles (CA DMV). The CA DMV's Driver Records Master (DRM) file includes documentation of all reported injury and property damage only (PDO) crashes and traffic violations (including dismissals) for California licensed drivers. For the TeenSMART group, the crash and traffic violation data used in the analyses that follow were based on reported events that occurred during the first year after an individual successfully completed the course. This approach is similar to the Thomas et al. (2016) study which included crash and violation data for a one-year period after the teen completed the assigned study training condition. Using the same data extraction and similar violation/crash summary approach made the two datasets as comparable as possible.

Results

Traffic Violations

A first step was to examine the violation rates by de-identified participant source for TeenSMART to make sure no obvious differences existed. A negative binomial regression analysis with participant source entered as a factor showed no statistically significant differences in numbers of violation ($p > .05$). As such, the violation data for all TeenSMART participant sources was combined and compared to the comparison group. Table 2 shows that the TeenSMART drivers (Violation rate = 7.70 per 100 drivers) had an approximately 54% lower overall violation rate than the comparison group (Violation rate = 16.63 per 100 drivers).

Table 2. Violations Per 100 Drivers For One Year Measurement Periods

		All TeenSMART		Comparison	
Sex	Age	Rate	n	Rate	N
Male	16	8.48	1663	14.56	412
	17	9.86	2393	19.82	333
	18	13.02	799	27.32	637
	Subtotal	9.01	4855	21.71	1382
Female	16	5.25	1599	6.28	366
	17	4.95	2022	10.45	287
	18	5.75	643	13.85	527
	Subtotal	5.18	4264	10.68	1180
Total	16	6.90	3262	10.67	778

17	7.61	4415	15.48	620
18	9.78	1442	21.22	1164
Total	7.70	9119	16.63	2562

To determine if the observed differences in violations were statistically significant, researchers utilized negative binomial regression to compare the TeenSMART and Comparison training groups. The model was calculated with training group, age, sex, and their interactions used to predict number of violations. The individual factor and full model likelihood chi-square results are shown in Table 3 below.

Table 3. Negative Binomial Regression For Number of Violations: All TeenSMART vs. Comparison

Factor	Likelihood Chi-Square Ratio	df	*p*-value
Intercept	3462.871	1	$p < 0.001$
Training Group	65.756	1	$p < 0.001$
Sex	78.786	1	$p < 0.001$
Age	25.855	2	$p < 0.001$
Training Group by Sex	.139	1	$p = 0.709$
Training Group by Age	5.872	2	$p = 0.053$
Sex by Age	.288	2	$p = 0.866$
Training Group by Sex by Age	1.827	2	$p = 0.401$

Full Model	$\chi^2 = 273.311$ $df = 11$ N = 11681 $p < 0.001$

The results showed a large main effect for training group, χ^2 (1, n = 11681) = 65.756, $p < 0.001$, which indicates a reliably lower violation count/rate for Teen SMART-trained drivers as a whole compared to the comparison group. None of the interactions involving training group were statistically significant (ps > .05).

Crashes

As with violations, the first step in analyzing crashes was to examine crash rates by participant source for TeenSMART to determine if obvious differences existed (See Table 4). A group of participants from a particular type of referral source had a total crash rate (injury and PDO combined) per 100 drivers (Rate = 10.49; N = 4740) that appeared higher than the other types of referral sources (Rate = 6.83, N = 4379). The total number of crashes for this group were compared to the other participant sources combined using Poisson regression. The analysis showed a main effect for participant source indicating the number of crashes was significantly higher ($p < .001$) for one type of source. As such, all comparisons of crashes to the comparison group were conducted twice; once with all other participant sources combined (designated herein as “TeenSMART 1”) and separately for the group that showed higher crash rates (designated as “TeenSMART 2”). The results that follow do not include participant counts by age and sex in order to protect the identity of the TeenSMART 2 group, which is proprietary by agreement.

Table 4. PDO, Injury, and Total Crashes per 100 Drivers by Study Group

	TeenSMART 1 (N=4379)		TeenSMART 2 (N=4740)		Comparison (N=2562)	
Crash Severity	Count	Rate per 100 Drivers	Count	Rate per 100 Drivers	Count	Rate per 100 Drivers
PDO	226	5.16	414	8.73	193	7.53
Injury	73	1.67	83	1.75	51	1.99
Total	299	6.83	497	10.49	244	9.52

Total Crashes. Table 5 shows that TeenSMART 1 as a whole had an approximately 28% lower total crash rate than the comparison group. TeenSMART 2 as a whole was about 10% higher than the comparison group. Separate Poisson regressions were used to determine if the differences in total crash counts were significantly different for TeenSMART 1 and TeenSMART 2 versus the comparison group. The models were calculated using training group, sex, age, and their interactions to predict number of total crashes.

Table 5. Total Crashes per 100 Drivers by Training Group, Age, and Sex

Sex	Age	TeenSMART 1 (N=4379) Rate per 100 Drivers	TeenSMART 2 (N=4740) Rate per 100 Drivers	Comparison (N=2562) Rate per 100 Drivers
Male	16	6.94	10.68	8.01
	17	7.04	10.99	12.91
	18	8.55	10.58	11.62
	Subtotal	7.28	10.82	10.85
Female	16	6.25	11.01	9.56
	17	7.10	10.12	5.23
	18	4.29	7.51	8.35
	Subtotal	6.30	10.12	7.97
Total	16	6.61	10.84	8.74
	17	7.07	10.58	9.35
	18	6.61	9.24	10.14
	Total	6.83	10.49	9.52

Note: Participant counts by age and sex group cannot be released when a single participant source could potentially be identified.

The individual factor and full model likelihood chi-square ratio results for TeenSMART 1 versus the comparison group are provided in Table 6 below. The results show a main effect for training group ($p = 0.002$) which indicates TeenSMART 1's approximately 28% lower crash count/rate was reliably lower than the comparison group. The results also showed a significant three-way interaction of training by sex by age ($p = .010$) indicating the crash rate differences among the TeenSMART 1 drivers and comparison group varied by age and sex combinations.

Table 6. Poisson Model for Total Number of Crashes: TeenSMART 1 vs. Comparison

Factor	Likelihood Chi-Square Ratio	df	*p*-value
Intercept	8964.612	1	$p < 0.001$
Training Group	9.628	1	$p = 0.002$
Sex	10.147	1	$p = 0.001$
Age	.021	2	$p = 0.990$
Training Group by Sex	.211	1	$p = 0.646$
Training Group by Age	1.902	2	$p = 0.386$
Sex by Age	6.682	2	$p = 0.035$
Training Group by Sex by Age	9.151	2	$p = 0.010$

Full Model	$\chi^2 = 35.583$ $df = 11$ N = 6941 $p < .001$

The individual factor and full model likelihood chi-square results for TeenSMART 2 versus the comparison group are shown below in Table 7. The results showed no main effect for training group ($p = 0.176$), which indicates the crash counts/rates were not significantly different for the two groups. No interaction effects involving training group were statistically significant (*p*s > .05)

Table 7. Poisson Model for Total Number of Crashes: TeenSMART 2 vs. Comparison

Factor	Likelihood Chi-Square Ratio	df	*p*-value
Intercept	8388.201	1	$p < 0.001$
Training Group	1.830	1	$p = 0.176$
Sex	7.399	1	$p = 0.007$
Age	.216	2	$p = 0.898$
Training Group by Sex	1.503	1	$p = 0.220$
Training Group by Age	2.944	2	$p = 0.230$
Sex by Age	8.719	2	$p = 0.013$
Training Group by Sex by Age	5.797	2	$p = 0.055$

Full Model	$\chi^2 = 19.836$ $df = 11$ N = 7302 $p = .048$

Injury Crashes. Table 8 shows that TeenSMART 1 as a whole had an approximately 16% lower injury crash rate than the comparison group. TeenSMART 2 as a whole was about 12% lower than the comparison group. Separate Poisson regressions were used to determine if the differences in injury crash counts were significantly different for TeenSMART 1 and TeenSMART 2 versus the comparison group. The models were calculated using training group, sex, age and their interactions to predict number of injury crashes. None of the main or interaction effects involving training group were statistically significant (ps > .05) for any of the analyses.

Table 8. Injury Crashes per 100 Drivers by Training Group, Age, and Sex

Sex	Age	TeenSMART 1 (N=4379) Rate per 100 Drivers	TeenSMART 2 (N=4740) Rate per 100 Drivers	Comparison (N=2562) Rate per 100 Drivers
Male	16	2.15	1.95	2.43
	17	1.20	1.95	1.80
	18	1.90	1.85	1.88
	Subtotal	1.64	1.94	2.03
Female	16	1.63	1.85	1.64
	17	1.97	1.36	0.70
	18	1.14	1.37	2.85
	Subtotal	1.70	1.55	1.95
Total	16	1.90	1.90	2.06
	17	1.54	1.67	1.29
	18	1.56	1.64	2.32
	Total	1.67	1.75	1.99

Property Damage Only (PDO) Crashes. Table 9 shows that TeenSMART 1 as a whole had an approximately 31% lower PDO crash rate than the comparison group. TeenSMART 2 as a whole was about 16% higher than the comparison group. Again, separate Poisson regressions were used to examine TeenSMART 1 and TeenSMART 2 versus the comparison group. The models were calculated using training group, sex, age and their interactions to predict number of PDO crashes.

Table 9. PDO Crashes per 100 Drivers by Training Group, Age, and Sex

Sex	Age	TeenSMART 1 (N=4379) Rate per 100 Drivers	TeenSMART 2 (N=4740) Rate per 100 Drivers	Comparison (N=2562) Rate per 100 Drivers
Male	16	4.80	8.73	5.58
	17	5.84	9.04	11.11
	18	6.65	8.73	9.73
	Subtotal	5.63	8.88	8.83
Female	16	4.62	9.15	7.92
	17	5.14	8.76	4.53
	18	3.14	6.14	5.50
	Subtotal	4.60	8.57	6.02
Total	16	4.71	8.94	6.68
	17	5.53	8.91	8.06
	18	5.06	7.60	7.82
	Total	5.16	8.73	7.53

The analysis of TeenSMART 1 versus the comparison group (Table 10) showed a significant main effect for training group ($p = .001$), which indicates TeenSMART 1's approximately 31% lower PDO crash count/rate was reliably lower than the comparison group. None of the interaction effects involving training group were statistically significant (*p*s > .05).

Table 10. Poisson Model for Number of PDO Crashes: TeenSMART 1 vs. Comparison

Factor	Likelihood Chi-Square Ratio	df	*p*-value
Intercept	9588.932	1	$p < 0.001$
Training Group	10.149	1	$p = 0.001$
Sex	9.488	1	$p = 0.002$
Age	.696	2	$p = 0.706$
Training Group by Sex	.091	1	$p = 0.764$
Training Group by Age	.576	2	$p = 0.750$
Sex by Age	10.617	2	$p = 0.005$
Training Group by Sex by Age	5.600	2	$p = 0.061$

Full Model	$\chi^2 = 39.394$ $df = 11$ N = 6941 $p < .001$

The analysis of TeenSMART 2 versus the comparison group (Table 11) did not show a significant main effect for training group (*p*s > .05), but there was a significant three-way interaction of training by sex by age (p = .044) indicating the PDO crash rate differences among the TeenSMART 2 drivers and the comparison group varied by age and sex combinations.

Table 11. Poisson Model for Number of PDO Crashes: TeenSMART 2 vs. Comparison

Factor	Likelihood Chi-Square Ratio	df	*p*-value
Intercept	8969.891	1	p < 0.001
Training Group	3.053	1	p = 0.081
Sex	5.934	1	p = 0.015
Age	.421	2	p = 0.810
Training Group by Sex	1.694	1	p = 0.193
Training Group by Age	1.547	2	p = 0.461
Sex by Age	10.585	2	p = 0.005
Training Group by Sex by Age	6.240	2	p = 0.044

Full Model	χ^2 = 23.981 *df* = 11 N = 7302 *p =.013*

Discussion

TeenSMART was designed to cover a set of topics (e.g., hazard anticipation, distraction management, speed management) that research suggests are related to teen driver safety. The program had multiple protections in place (e.g., tests, time monitoring) to ensure the young drivers completing the program were attending to the materials and engaging with the program. Given the program's scientific underpinnings and use of control strategies to ensure participants are paying attention to the material, it is not surprising to find lower traffic violation rates, and potentially lower crash rates, among young drivers who successfully completed the program.

Most notably, the entire sample of young drivers who completed the TeenSMART training program, regardless of participant source, age, and sex, had substantially lower traffic violation rates in the year after program completion than did a group of similarly aged teens from the same state. The demonstration of lower traffic violation rates (approximately 54% lower overall) for TeenSMART-trained teens in this study is extremely robust and suggestive of a conclusion that drivers who successfully completed the TeenSMART program drove in a more law-abiding manner than did the comparison group.

The results regarding crashes were also suggestive of a safety effect from TeenSMART but were somewhat dependent on the source of the TeenSMART participants. Approximately half of the TeenSMART sample (N = 4379) that came from multiple types of referral sources showed a 28% lower total crash rate and a 31% lower property damage only crash rate relative to the comparison group (ps $< .01$). The same group of participants also showed a 16% lower injury crash rate, but the difference was not statistically significant ($p > .05$). TeenSMART participants from another source were analyzed separately and showed no difference in PDO crash rates compared to the comparison group ($p > .05$). teenSMART 2 did, however, show a 12% lower injury crash rate than the comparison group, but the difference was not statistically significant ($p > .05$). These are fairly large reductions in injury crashes for both teenSMART groups, but statistical significance was likely not achieved because of the still relatively small number of injury crashes across all groups in the study which limited the power of the analyses.

The lower violation and crash rates observed in this study are consistent with what an insurance company must show when submitting to the California Department of Insurance (CADOI) to have a premium reduction applied for customers who complete a course such as TeenSMART. The CA DOI requires solid evidence that a program works to improve safety before an insurance provider is allowed to issue a premium discount. The fact that a premium reduction has been granted for teenSMART in California suggests these insurers have ample actuarial evidence, using comparison groups from their own customer population, that the program does in fact improve young driver safety. The teenSMART program is the only teen driver safety program approved by the CADOI for a 20% premium discount.The results of this study are an independent confirmation of the likely safety benefits associated with completion of the TeenSMART program.

The findings of this independent study are suggestive that teenSMART and, by analogy, similar programs can indeed improve young driver safety. The premium reductions allowed by various state insurance boards for the completion of teenSMART suggest the insurance carriers are providing similar actuarial evidence to back up this conclusion. teenSMART, or a similar program, can easily be integrated into existing GDL programs and may be most useful as part of *Phase 2 Driver Education* after a young driver has received the first license for unsupervised driving as suggested by Mayhew et al. (2016).

More work is needed to determine if additional information such as the psychometric measures (e.g., test scores, pattern of clicks on hazards in simulations) collected during teenSMART administration can be used to better predict who will have a crash or be more susceptible to violations. Through such analyses, it may be possible to gain a better understanding of risk factors for crash-prone individuals and tailor training to address an individual's specific needs.

Limitations. As with any study of this type, the findings are not without some limitations. While the crash and violation data came from the same source, the data are from different time periods with the teen drivers coming from different sources. The comparison group was recruited at DMV offices while the experimental participants self-selected to complete teenSMART for an insurance discount from a variety of insurers or driving schools. As such, differences in other factors (e.g., driving environment, economic changes, vehicle technology, and socioeconomics) during the different time periods and among the groups could have influenced the findings. A more carefully matched comparison group of drivers from the same time period, or a study that randomly assigns teen drivers to complete TeenSMART or placebo training, would be required to account more confidently for these potential confounding factors.

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