



46 **ABSTRACT**

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48 According to the National Institutes of Health, car crashes kill and injure more young  
49 people than any other cause, accounting for nearly half of all teen deaths in America each  
50 year at a rate of more than 3,500 teens annually. In response to this public health crisis,  
51 the Texas Transportation Institute created Teens in the Driver Seat® (TDS), the first  
52 peer-to-peer program in the U.S. focused solely on teen driving safety. The program  
53 directly involves teens in developing and delivering important safety messages to their  
54 peers. Since the program's deployment began in 2003, Texas is the only state in the  
55 nation to experience a decline in fatal crashes involving teen drivers each and every year  
56 – now down a total of 45 percent from 2003 to 2010. In comparison, fatal crashes  
57 involving adult drivers have only decreased 15 percent over that same period. The  
58 purpose of this paper is to present a basic overview of the TDS program and provide a  
59 detailed description of the statistical analysis used to assess the program's performance.  
60 A before-and-after study with treatment and comparison group was conducted to evaluate  
61 the effectiveness of the program. The treatment group (10 counties with TDS) and  
62 comparison group (10 counties without TDS) were selected and compared based on  
63 similar characteristics (demographics and crash trends). The results showed a 14.6 percent  
64 average reduction (statistically significant at the 99 percent confidence level) in teen  
65 crashes in Texas counties where TDS was implemented.

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67 *Keywords: Teen Crashes, Teens in the Driver Seat, Before-After Study.*

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## 92 **1. INTRODUCTION**

93 According to the National Institutes of Health, car crashes kill and injure more teenagers  
94 across the United States each year than any other cause. Approximately 3,500 young  
95 people die in this way annually across the nation – the equivalent of a commercial jet full  
96 of teens crashing once every other week for an entire year. The financial cost of these  
97 deaths exceeds \$40 billion annually. In addition, for every teen killed in a crash, 50 more  
98 are seriously injured. In response to this growing public health crisis, the Texas  
99 Transportation Institute has created “Teens in the Driver Seat®,” the first driving safety  
100 program in the U.S. focused solely on this issue that directly involves teens in developing  
101 and then delivering important safety messages to their peers.

102 The TDS Program is based on research findings showing that teens are significantly  
103 influenced by each other (i.e., their peers), and that the peer-to-peer communication  
104 culture and pressures are important factors that influence youth behavior. One of the  
105 important goals of the TDS Program is to leverage that peer-to-peer communication  
106 dynamic and network in order to increase awareness of primary teen driving risks, and  
107 ultimately improve teen driving behavior and decrease the frequency of automobile  
108 crashes involving teen drivers.

109 Messages and TDS Program materials shed light on the consequences of the combination  
110 of driver inexperience coupled with the most common risk factors for young drivers:  
111 driving at night, distractions (such as cell phones, “texting” and too many teen  
112 passengers), low seat belt use, speeding, and alcohol. This approach represents a sharp  
113 departure from long-established safety outreach efforts in two ways. First, every aspect of  
114 the program is influenced in some way by the target audience. Second, messages focus  
115 less on alcohol and more on what statistics show to be more common (and lesser known)  
116 driving risk factors among teens. A wide variety of resources are provided to the teens to  
117 deploy such messages throughout their schools and communities.

118 The TDS program was first introduced in Texas in 2002 through funding provided by the  
119 San Antonio District of the Texas Department of Transportation (TxDOT). The TDS  
120 program is now supported through TxDOT’s 402 Safety Program and State Farm of  
121 Texas.

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## 123 **2. TEENS IN THE DRIVER SEAT PROGRAM DESCRIPTION**

124 The Teens in the Driver Seat program is available to Texas public and private schools at  
125 no cost. The program has been started in more than 550 Texas schools. Typically, the  
126 program is managed by ten to fifteen student leaders who are responsible for planning  
127 and conducting activities and involving peers to spread driving safety messages. The  
128 activities and communication strategies designed by the students vary widely in many  
129 cases, but all efforts share one common distinction – the messages are developed and  
130 delivered exclusively by students and their peers. A network of several TTI staff  
131 members is available to assist the student teams with specific needs, but these staff  
132 members operate completely in the background, leaving each school’s program free of  
133 “adult fingerprints” and thus more likely to be viewed as credible and resonate with  
134 young drivers and passengers. In a broader sense, the program is led in part by the Teens

135 in the Driver Seat Program Teen Advisory Board, a group of 15 high school students  
136 from different communities in the State of Texas who meet quarterly and provide  
137 ongoing insight and guidance to ensure program effectiveness.

138 The program is marketed to potential program schools through its website: [www.t-](http://www.t-driver.com)  
139 [driver.com](http://www.t-driver.com). Additional promotion has been generated through television and radio public  
140 service announcements, along with occasional press conferences led by student team  
141 members at TDS program schools. The program is also strongly represented in the  
142 statewide networks of the Texas Association of Student Councils and the Family, Career  
143 and Community Leaders of America organization in Texas. Through its wide range of  
144 activities, the program has directly reached more than 600,000 students in Texas.

145 Teens in the Driver Seat is the recipient of more than ten national awards, including the  
146 Governor's Highway Safety Association's Peter K. O'Rourke Special Achievement  
147 Award, the National Safety Council's Teen Driver Safety Leadership Award, the  
148 Institute of Transportation Engineers Transportation Achievement Award for Safety  
149 (twice), and the American Association of State Highway Transportation Officials  
150 President's Safety Award. The program has also been recognized as a national best  
151 practice for safety the past three years in a row.

152 The program's effectiveness has been demonstrated in a number of ways, including:

- 153 - Up to 200 percent improvement in awareness of teen driving risks
- 154 - A 14 percent increase in seat belt use by teen drivers and passengers
- 155 - A 30 percent reduction in cell phone use by teen drivers

156 Texas has experienced an especially significant drop in teen-driver crashes in recent years  
157 – more than a 45 percent drop in fatal crashes, in fact (see Figure 1). Two of the most  
158 significant developments during that time were the implementation of the state's  
159 graduated driver license law (GDL) in 2002, and the introduction of the Teens in the  
160 Driver Seat Program.

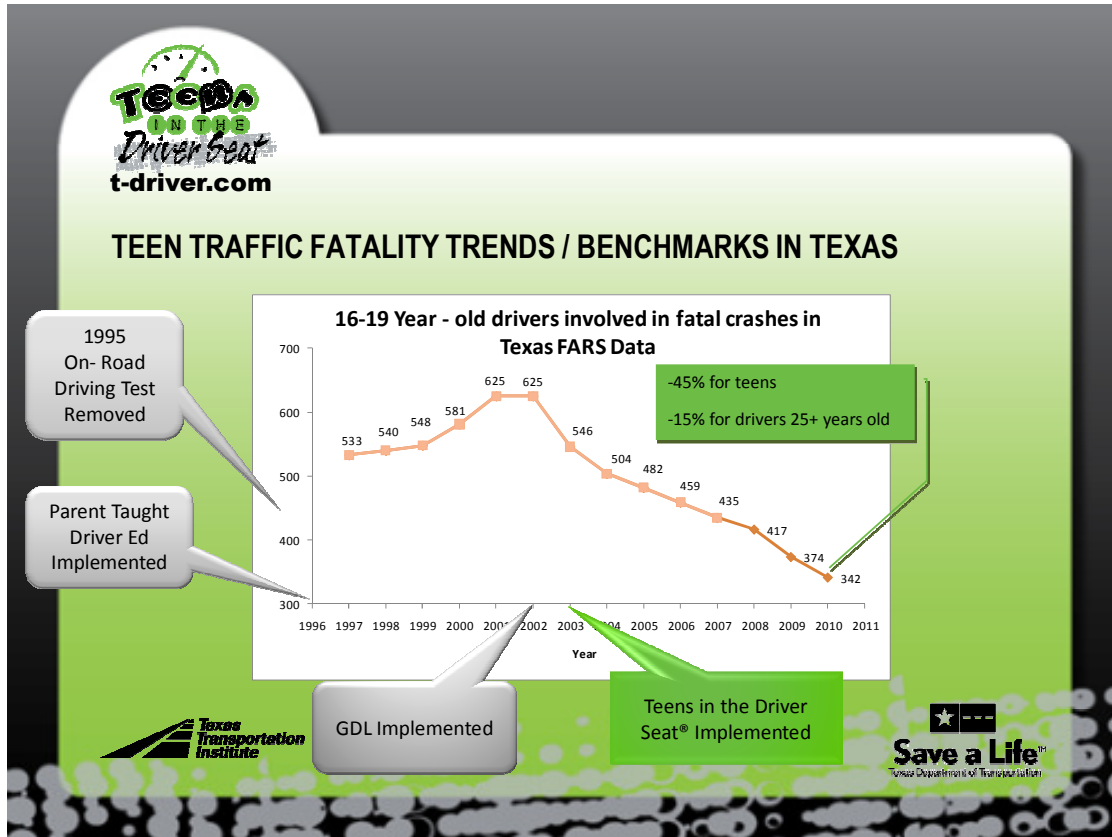


Figure 1: Teen Traffic Fatality Trends in Texas.

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According to research prepared for the AAA Foundation for Traffic Safety in 2007 (1), GDL laws have brought about an 11 percent reduction in fatal crashes and a 19 percent drop in injury crashes. Similarly, a 2009 analysis by the Insurance Institute for Highway Safety (2) noted that states with GDL laws similar to that in Texas should expect an average 11 percent reduction in fatal crashes involving 16-year-old drivers. Still other research suggests that GDL laws are responsible for a 5.8 percent reduction in crashes involving 15- to 17-year-old drivers (3). Illustrated in Figure 2 are the expected impacts of GDL in Texas compared to the improvements that have actually occurred for teens in Texas. Apart from the introduction of a GDL in Texas, the impact of other factors has not been fully assessed.

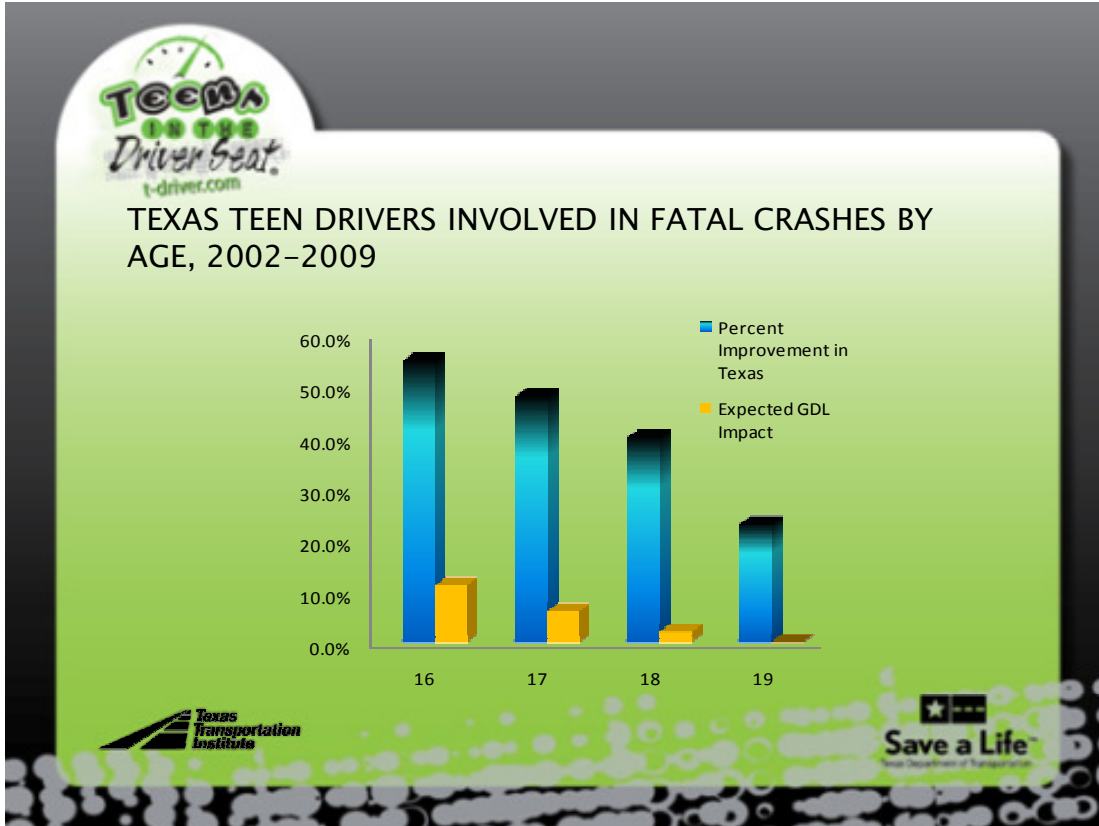


Figure 2: Percent Change in Fatal Crashes in Different Age Groups.

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178 **3. PROGRAM EFFECTIVENESS**

179 Following are a variety of assessment activities and data associated with assessing the  
180 progress of the TDS Program.

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182 **3.1. Teen Awareness of Top Driving Risks**

183 One key performance measure for the TDS Program was to raise teen awareness of the  
184 top driving risks they face as novice drivers. Table 1 summarizes the teen awareness of  
185 top driving risks before and after implementation of the TDS program. The largest pre-  
186 and post-program data sample (1,105 pre- and 617 post-samples) was obtained from  
187 Garland High School, Garland, Texas.

188 Overall there were significant increases in the majority of the top risks faced by teen  
189 drivers. In addition to the noteworthy increases in most individual risk awareness levels,  
190 the percentage of teens able to cite at least four risks increased by 156%, and the number  
191 of teens able to cite five risks correctly increased by 500% -- all signs that there were, in  
192 general, solid increases in teen driving risk awareness after TDS Program  
193 implementation. That noted, it appears greater emphasis may be warranted for the risks of  
194 speeding and drinking & driving.

195 Stated alternatively, the performance measure target for this topic area was to accomplish  
196 at least a 50% awareness level of the top risk factors faced by teen drivers. As shown in

197 Table 1, this target has been met for “cell phone use/texting” and “drinking & driving.”  
 198 Risk awareness for “speeding” and “teen passengers” was just shy of the 50%  
 199 benchmark, with significant improvement still needed in the areas of “driving at night”  
 200 and “seat belt use” in order to reach the 50% level.

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**Table 1: Summary of Garland High School Risk Awareness Data**

<b>Teen Driving Risk</b>	<b>Pre-TDS % Aware (n = 1,105)</b>	<b>Post-TDS % Aware (n = 617)</b>	<b>Net Change</b>	<b>Percent Change</b>
Driving at night	1	14	+ 13	+ 1,300%
Teen passengers	31	43	+ 12	+ 39%
Cell phone/ “texting”	60	83	+ 23	+ 38%
Seat belt use	13	16	+ 3	+ 23%
Speeding	48	47	- 1	- 2%
Drinking & driving	84	77	-7	- 8%

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**3.2. Teen Seat Belt use**

206 TTI conducted observational surveys in Garland, Texas in 2007 and selected nearby  
 207 Mesquite, Texas as a comparison city that did not participate in the program. Teens in  
 208 the Driver Seat was launched in Garland, Texas in 2007 and was a very active program  
 209 during its first year, engaging each high school in the city and making the surrounding  
 210 community more aware of teen traffic safety issues through a highly publicized press  
 211 event to kick off the program. Four high schools in each city were surveyed at two  
 212 intervals. Table 2 summarizes the safety belt use for these two school districts at the end  
 213 of 2007 (before period) and 2008 (after period). Garland remained an active participant  
 214 in the Teens in the Driver Seat program, while Mesquite was not. The survey results  
 215 (seen in Table 2) show that Garland teen safety belt use continued to improve as it had  
 216 the preceding year, while Mesquite teen belt use declined slightly. Back seat passenger  
 217 safety belt use in both cities continues to be very low, despite the legal mandate in Texas  
 218 that passengers under 17 use safety belts regardless of their seating position.

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**Table 2: Teen Belt Use, Garland compared to Mesquite School District,**

<b>Category</b>	<b>Garland, with TDS Program</b>		<b>Mesquite, no TDS Program</b>	
	<b>Before (n = 1308)</b>	<b>After (n=1566)</b>	<b>Before (n = 1672)</b>	<b>After (n=1491)</b>
Driver	90.8	93.5	83.6	80.7
Front Passengers	77.3	89.1	67.4	66.8
Back Passengers	48.8	40.6	27.0	33.3
Overall	85.7	90.2	77.4	75.3

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222 The target performance measure for seat belt use at TDS Program schools was to  
 223 demonstrate an increase of 10 percent. The results of the seat belt increase at a rural  
 224 school conducting a limited deployment of TDS was +8.5%, while the overall seat belt  
 225 use at an urban school deploying the TDS Program in earnest was +19.8% better than

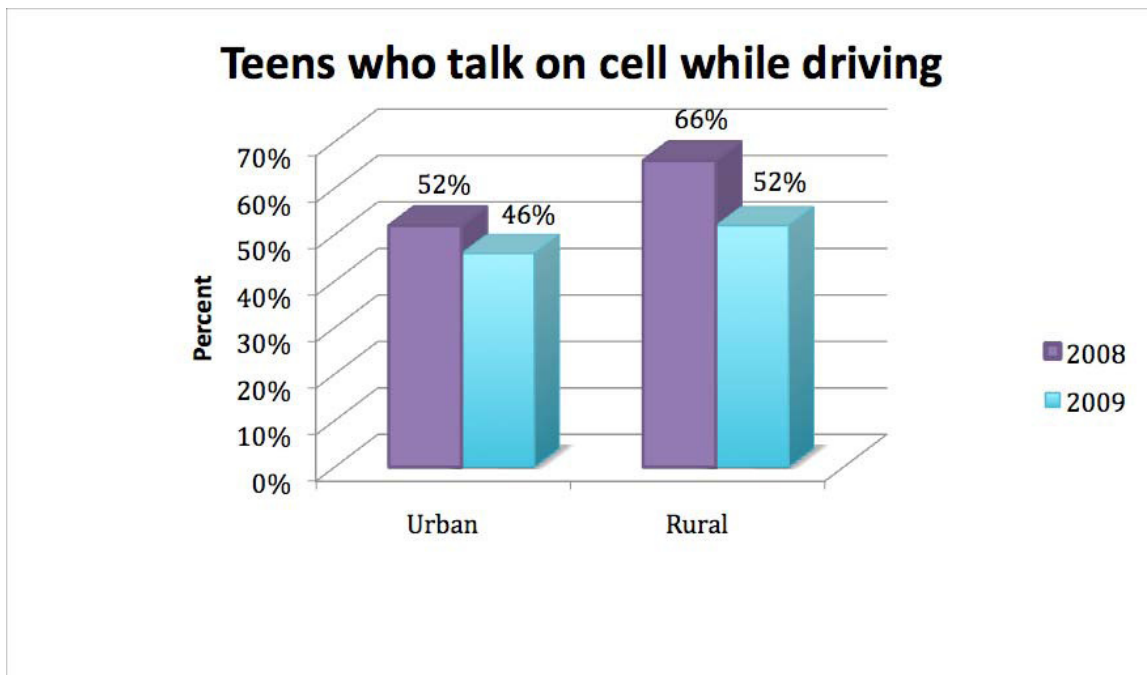
226 seat belt use at a neighboring school who did not take part in the program. Noteworthy  
227 year-over-year improvements were also accomplished at this latter school (i.e., Garland  
228 HS).

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### 230 3.3. Teen Use of Wireless Devices While Driving

231 Self-reported driving behavior of teens that is routinely gathered as part of the TDS  
232 Program is illustrated in Figures 3 and 4. These figures give a summary of teens who  
233 responded “yes” to the survey question of “Have you used your cell phone or “texted”,  
234 while driving within the past month?” Data presented therein show that, during the 2008-  
235 2009 school year, 49 percent of teens used their cell phone at least once per month while  
236 driving. The frequency varied slightly between urban and rural teens, with rural teens  
237 being more likely to do so. This same dynamic was seen when it came to teens that “text”  
238 while driving, although teens were less likely to “text” and drive in comparison to talking  
239 on a phone while driving.

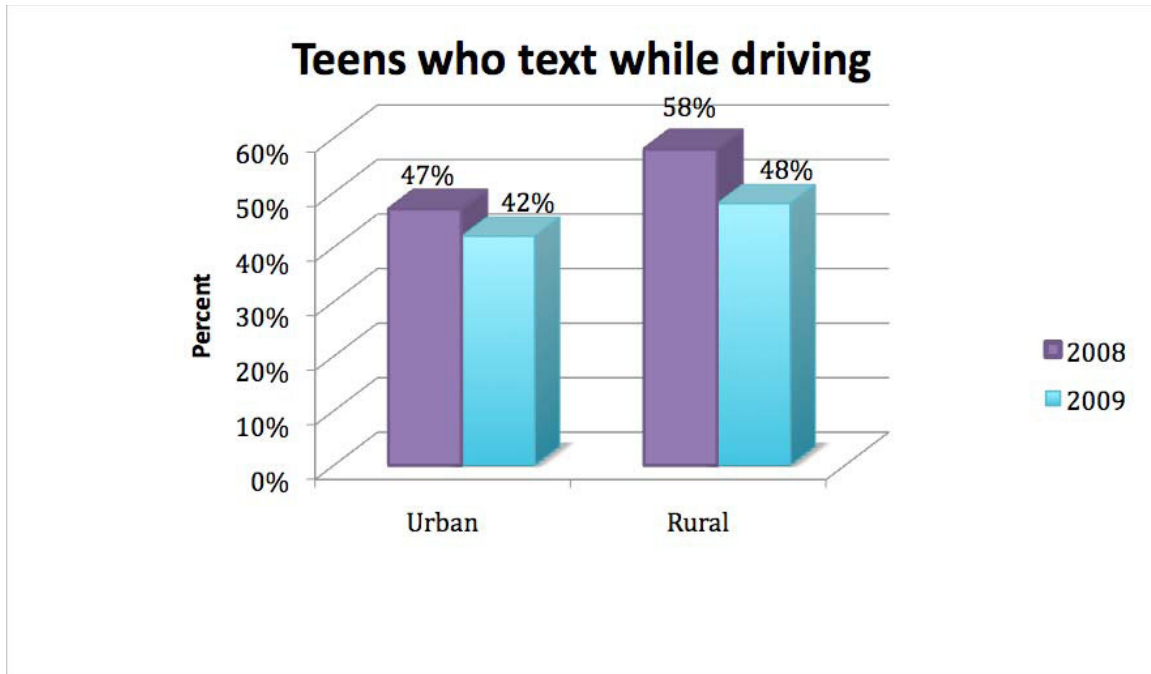
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242 **Figure 3: Percentage of Teens Who Talk on Cell Phone While Driving at Least Once**  
243 **per Month**

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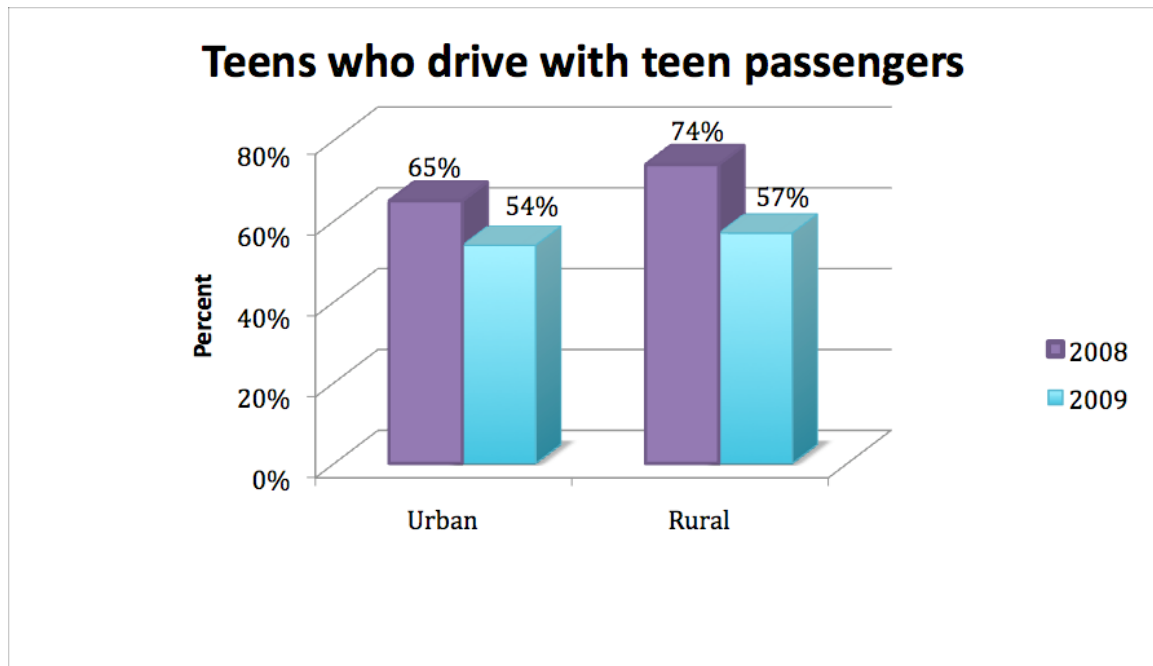
**Figure 4: Percentage of Teens “Texting” While Driving at Least Once per Month**

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### 3.4. Teen Drivers Carrying Teen Passengers

249 One of the goals of the TDS program is to decrease the number of teen drivers who travel  
250 with teen passengers without an adult present (consistent with good graduated driver  
251 licensing (GDL) practices). Data gathered as part of the teen seat belt use field  
252 observations indicate that approximately 10 percent of teen drivers were traveling with  
253 teen passengers. Shown in Figure 5 is a summary of teen drivers who, based upon their  
254 self-reported driving behavior, carry teen passengers (without an adult present) at a  
255 frequency of at least once per month. As noted therein, this situation has improved  
256 significantly during after the deployment of TDS program. As with cell phone use and  
257 “texting”, this activity is more prevalent amongst rural teens. The source of these data is  
258 the same surveys (over 18,000 total) within the TDS Program database. The goal was to  
259 have less than 70 percent of teen drivers traveling with teen passengers. That goal was  
260 achieved, as well as an overall (significant) decrease from the 2007-2008 school/contract  
261 year.

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**Figure 5: Percentage of Teen Drivers Who Carry Teen Passengers (without an Adult present) at Least Once per Month**

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### 3.5. Safety Benefits

268 To provide an insight into the safety benefits of the TDS program, a review of the teen  
269 crashes in counties where the program was implemented was conducted. Data on crashes  
270 involving teens that occurred on the Texas state highway system from 2003 through 2009  
271 were obtained from the Texas Department of Transportation (TxDOT) Crash Records  
272 Information System (CRIS). The dataset contained information on crash severity, crash  
273 type, roadway information, environmental condition, driver gender and age, vehicle age,  
274 and driving under alcohol influence among others. Since it is widely-recognized that  
275 property damage only (PDO) crash counts vary widely on a regional basis due to  
276 significant variation in reporting threshold, only those crashes that are associated with  
277 injury or fatality were considered in this study.

278 A detailed before-after study was used to evaluate the safety effectiveness of TDS  
279 program in Texas. To overcome some of the limitations with a simple or naïve before-  
280 after study, the comparison group method was used in this analysis. This method uses a  
281 group of comparison sites selected as being similar to the treated sites in terms of  
282 geographic characteristics and crash trends. Two assumptions underlying this approach  
283 are: (a) the factors that affected safety have changed in the same way for both the  
284 treatment and the comparison groups, and (b) the changes in the various factors influence  
285 the safety of the treatment and the comparison groups in the same manner (4). The results  
286 from this approach are considered more accurate and reliable than the simple before-after  
287 study because it can help account for external causal factors and maturation problems.  
288 The results are, however, greatly dependent on the availability of comparison sites, as  
289 well as the similarity between the comparison and the treated sites. While this approach  
290 can improve upon the weakness of a simple before-and-after study method (by carefully  
291 selecting the comparison groups), it is still subject to the regression-to-the-mean bias

292 because it predicts the expected number of target crashes of a site based on the before-  
293 period crash data.

294 The procedures for using the before-after study with the comparison group method are  
295 described in more detail as follows:

296 **Step 1. Select the treatment group**

297 The TDS program was originally developed and pilot-tested in 2001-2002. In each  
298 subsequent year, there was a significant increase in the number of participating schools.  
299 As of the 2010-11 year, the TDS program had been implemented in schools in 101  
300 counties in Texas.

301 Because the crash data were available only until 2009 at the time of this analysis,  
302 counties where the TDS program started after the year 2009-10 school year were not  
303 considered in the analysis. In addition, counties where there was a discontinuity in the  
304 TDS program prior to 2009 were also not considered.

305 **Step 2. Define the comparison group**

306 The comparison groups were selected in such a way that the factors external to the TDS  
307 Program that affected safety have changed in the same way as that of the treated group  
308 and the change in the various factors influence the safety of the treatment and the control  
309 groups in the same manner. The following restrictions were imposed in selecting a  
310 comparison group:

- 311 1. The comparison county should be located in the same geographical area as that of  
312 the treated county (i.e. east, west, north or south Texas).
- 313 2. The trend in the teen crashes before the implementation of the TDS program  
314 should be the same in both treatment and comparison county such that the  
315 expectation of odds ratio, ' $\omega$ ' is equal to 1, as defined in Hauer (4).  
316

317 **Step 3. Predict the expected number of crashes and variances for after period**

318 The expected number of after-period crashes and their variances for site  $i$  had the  
319 treatment not been implemented at the treated site is given as (4):

$$320 \quad \hat{\pi} = \hat{r}_T K \text{ and } \hat{V}AR(\hat{\pi}) = \hat{\pi}^2 \left[ 1/K + \hat{V}AR\{\hat{r}_T\}/r_T^2 \right]$$

$$321 \quad \text{with, } \hat{r}_T = (N/M)/(1+1/M) \text{ and } \hat{V}AR\{\hat{r}_T\}/r_T^2 \cong 1/M + 1/N$$

322 where,

323  $K$  = total crash counts during the before period in the treated county

324  $M$  = total crash counts during the before period in the comparison county

325  $N$  = total crash counts during the after period in the comparison county  
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327 **Step 4. Compute the sum of the predicted crashes over all treated sites and its variance**

$$328 \quad \hat{\pi} = \sum_{i=1}^N \hat{\pi}_i \text{ and } Var(\hat{\pi}) = \sum_{i=1}^N Var(\hat{\pi}_i)$$

329 Where,  $N$  is the total number of sites in the treatment group, and  $\hat{\pi}$  is the expected after-  
330 period crashes at all treated sites had there been no treatment.

331 **Step 5.** *Compute the sum of the actual crashes over all treated sites*

$$332 \quad \hat{\lambda} = \sum_{i=1}^N L_i$$

333 where  $L_i$  is the total crash counts during the after period at site  $i$ .

334 **Step 6.** *Compute the unbiased estimate of safety-effectiveness of the treatment and its*  
335 *variance*

$$336 \quad \hat{\theta} = \frac{\left(\frac{\lambda}{\pi}\right)}{\left(1 + \frac{Var(\hat{\pi})}{\hat{\pi}^2}\right)}$$

337 The percent change in the number of target crashes due to the treatment is  
338 calculated by  $100(1 - \hat{\theta})\%$ . If  $\hat{\theta}$  is less than 1, then the treatment has a positive safety  
339 effect.

340 The estimated variance and standard error of the estimated safety-effectiveness  
341 are given by

$$342 \quad Var(\hat{\theta}) = \hat{\theta}^2 \frac{(1/L + Var(\hat{\pi})/\hat{\pi}^2)}{(1 + Var(\hat{\pi})/\hat{\pi}^2)^2}$$

$$343 \quad s.e.(\hat{\theta}) = \sqrt{Var(\hat{\theta})}$$

344 The approximate 95% confidence interval for  $\theta$  is given by adding and subtracting  
345  $1.96s.e.(\hat{\theta})$  from  $\hat{\theta}$ . If the confidence interval contains the value 1, then no significant  
346 effect has been observed.

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348 Table 3 summarizes the estimated teen crash reductions after the implementation of the  
349 TDS program. The percent reduction in the number of crashes,  $100(1 - \hat{\theta})$ , shows that  
350 there is an 14.6 percent reduction in teen crashes. The standard error of the decrease is  
351 4.2 percent, which means that, at 5 percent significance level, one can expect a crash  
352 reduction anywhere from 6.4 percent to 23 percent. Also, since the 95 percent  
353 confidence interval for  $\hat{\theta}$  does not include 1, the observed reduction is statistically  
354 significant. The decrease in teen crashes is statistically significant at the 99 percent  
355 confidence level.

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**Table 3. Before-After Analysis of the TDS Program**

County	Treatment		Comparison		Estimates			
	Before	After	Before	After	$\lambda$	$\pi$	VAR( $\lambda$ )	VAR( $\pi$ )
	K	L	M	N				
Bandera	122	96	295	233	96	96.69	96	148.4
Burleson	163	66	356	149	66	68.41	66	73.3
Cass	190	78	1081	588	78	103.44	78	84.4
Fayette	170	91	443	220	91	84.61	91	90.8
Atascosa	179	80	287	181	80	113.28	80	187.3
Hopkins	311	157	889	514	157	180.02	157	203.7
Jasper	216	122	432	212	122	106.25	122	131.6
Wilson	212	87	783	373	87	101.12	87	88.7
Washington	284	180	338	315	180	265.46	180	680.3
Measure	Description						Value	
$\hat{\lambda}$	Number of crashes observed during the after period						957	
$\hat{\pi}$	Expected number of crashes during after period had TDS program not been implemented						1119.3	
Var( $\hat{\pi}$ )	Variance of $\hat{\pi}$						1688.6	
$\hat{\theta}$	Unbiased estimate of index of effectiveness						0.854	
$\sigma(\hat{\theta})$	Standard error of $\hat{\theta}$						0.042	
$100(1-\hat{\theta})$	Percent reduction in the number of crashes						14.6%	
$(\theta_{lower}, \theta_{upper})$	95% confidence interval for $\theta$						(0.77, 0.94)	
Significance	Statistical significance level						99.9%	

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365 **4. CONCLUSIONS**

366 The purpose of this paper is to assess the effectiveness of the Teens in the Driver Seat  
 367 program and its impact on reducing the frequency of teen driver crashes. A variety of  
 368 activities such as teen awareness of top driving risks, seat belt use, cell phone use, and  
 369 carrying teen passengers were assessed. The data associated with assessing the progress  
 370 of the TDS Program showed that there is a significant positive change in the driving  
 371 behavior of the teen drivers after the implementation of the TDS program.

372 The paper also primarily focuses on a review of teen crashes in counties where the  
 373 program was implemented, making comparisons to counties with similar characteristics  
 374 where the program was not in place. Further, to evaluate the safety benefits, this paper  
 375 utilized a before-after study with a comparison group so as to account for factors that  
 376 change over time. A detailed analysis achieving a high confidence level shows that the  
 377 Teens in the Driver Seat program has been effective in reducing teen driver crashes by  
 378 nearly 15 percent, demonstrating that the program has had a statistically significant  
 379 impact on the overall decline in teen-driver crashes in Texas. The 45 percent teen traffic  
 380 fatality reduction in Texas is far greater than the reduction to be expected from

381 introduction of a GDL law. This analysis demonstrates that the TDS Program is another  
382 significant contributor to the declining teen-driver crash frequency in Texas.

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