



Published in final edited form as:

J Safety Res. 2025 July ; 93: 24–30. doi:10.1016/j.jsr.2025.02.003.

A novel technological approach to preventing distracted driving

Haley J. Bishop^{a,*}, Morgan O'Donald^a, Lauren O'Malley^a, Kristina B. Metzger^a, Matthew Knutson^b, Kevin Kramer^b, Ryan Chamberlain^b, Sara Seifert^b, Allison E. Curry^a

^aCenter for Injury Research and Prevention, Children's Hospital of Philadelphia, 2716 South St, 13th Floor, Philadelphia, PA 19146, USA

^bMinnesota HealthSolutions Corporation, 861 E Hennepin Ave., Suite 440, Minneapolis, MN 55414, USA

Abstract

Objective: Several factors increase crash risk for teen drivers, including vulnerability to distraction and increased propensity to engage in risky driving behaviors such as smart phone use while driving (SPUWD). The current study evaluated the efficacy of an augmented LifeSaver smartphone app in reducing SPUWD among teen drivers and their parents.

Method: Objectively collected app data and survey data were used to evaluate the app's effectiveness in reducing SPUWD and its usability and acceptability among teen drivers and their parents.

Results: Data collected by the LifeSaver app revealed no significant decrease in overall SPUWD, however parents spent significantly less time using social media apps while certain features of the app were enabled.

Conclusions: Parents expressed reluctance to change their own distracted driving behavior but preferred that their teens not engage in that same behavior. This important finding suggests that anti-distracted driving interventions must target not only teens but families as a whole.

Keywords

Distracted driving; Smartphone app; Teen driver

*Corresponding author. bishoph4@chop.edu (H.J. Bishop).

CRedit authorship contribution statement

Haley J. Bishop: Writing – original draft, Methodology, Investigation, Conceptualization. **Morgan O'Donald:** Writing – review & editing, Investigation. **Lauren O'Malley:** Project administration, Methodology, Investigation. **Kristina B. Metzger:** Methodology, Formal analysis, Conceptualization. **Matthew Knutson:** Software, Methodology, Data curation, Conceptualization. **Kevin Kramer:** Software. **Ryan Chamberlain:** Software. **Sara Seifert:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Allison E. Curry:** Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

1. Introduction

Traffic-related injuries and fatalities remain a major health risk in the United States, and smart phone use while driving (SPUWD) significantly increases the risk for a motor-vehicle crash (AAA, 2021). Teen drivers, 95% of whom report owning a smartphone, account for a disproportionate number of these distracted driving deaths and crashes (Vaterlaus et al., 2021). Teens are also the age group most likely to use a smartphone while driving, with 52% of U.S. drivers ages 18 to 29 reporting texting or e-mailing while driving at least once in the last 30 days (Porter, 2010).

When asked about their feelings toward their mobile phones, teens report that their mobile phones help them stay connected to peers, communicate attributes of their identity, convey social status, and provide a safety net in case they get lost or need to get in touch with parents (Hafetz et al., 2010; White et al., 2010). Teens have also reported that accessibility to portable electronic devices has led to an increase in distracted driving (Gershon et al., 2017). Given that novice teen drivers are less skilled at detecting and responding to road hazards, anything that takes teen drivers' attention away from the driving task is a dangerous distraction (Pradhan et al., 2005). Self and peer acceptance and perceived threats to personal safety all impact the choice teens make to use a smartphone while driving (Stavrinos et al., 2020). Beginning with their time as child passengers, children observe the traffic behaviors of their parents, and teens who reported that their parents engaged in distracted driving behaviors were more likely to engage in distracted driving behaviors themselves (Carter et al., 2014; Schmidt et al., 2014; Bingham et al., 2015). Teenage drivers report being distracted most often by calls from their parents and texts from their friends, with phone calls being perceived as more important to answer, especially when they are from parents (Stavrinos et al., 2020; LaVoie et al., 2016; McDonald & Sommers, 2015). Additionally, teens often use their mobile phones for practical purposes, like communicating with others about their arrival time and using navigation systems to avoid getting lost (Hafetz, 2010). SPUWD prevention approaches should consider the social context of mobile device use, which is often practical in nature and "well-meaning," as well as the fact that most teens are aware of the dangers of distracted driving (McDonald & Sommers, 2015).

Many different approaches have been used to reduce SPUWD among teen drivers. Legal bans on SPUWD have shown only modest results, likely due to the difficulties of enforcement (Delgado et al., 2016). In-person courses to educate teens about the risks of distracted driving have effectively increased protective behaviors among teens (Buczek et al., 2022; Berlin et al., 2021). Web-based anti-distracted driving platforms better accommodate families' pace and daily life and are more cost-effective and accessible than in-person interventions, but more research is necessary to define behavioral changes in the teens and parents participating in these studies (Classen et al., 2019; Salay et al., 2021). Courses that have integrated both in-person components in schools and web-based accountability programs have also yielded reductions in distracted driving (Buczek et al., 2022).

Currently available technology to limit mobile phone use while driving has significant limitations. Notably, software-only solutions are unable to differentiate between drivers and

passengers. Thus, they prohibit smartphone use—regardless of whether the user is a driver or passenger—when the vehicle is traveling above a designated speed. To overcome this limitation, some systems have utilized vehicle additions or modifications to differentiate between drivers and passengers; however, such systems only work in designated vehicles with a paired phone. Teens' dependence on mobile phones makes behavioral intervention efforts difficult, underscoring the need for a strong strategy for behavior change that includes advances in technologies that can impede drivers from using mobile phones unsafely. A technological intervention that blocks use effectively *and* accurately distinguishes between mobile phone use by a passenger versus a driver is ideal.

1.1. Development of the LifeSaver app augmentation

We augmented the LifeSaver smartphone app, which is designed to block SPUWD, to include cutting-edge technological intervention that overcomes impediments that have beset prior technologies. The augmented app will be referred to as the “app” in the remainder of this paper, more extensive details of the development of the augmentation can be found in a separate paper (Knutson et al., 2021). Briefly, the app included a novel interlock solution that allows passengers of moving vehicles to fully use their phones while limiting drivers to use music and navigation apps (hereby referred to as “allowed apps”). The app was programmed to run in one of three modes for the study to determine which app features were most successful at reducing distracted driving. (1) While in **background mode**, the app collected information about each drive the participant took in a motor vehicle (GPS location, date, time, list of apps used); there was no user interface, and the app did not prevent participants from using the smartphone. This mode allowed us to gauge baseline SPUWD. (2) In **manual mode**, the app blocked smartphone use (except for navigation and emergencies) while the vehicle was in motion unless the user identified themselves as a passenger by pressing a “passenger unlock” button. This “passenger unlock” feature was designed to allow users who were passengers to use their smartphone without restriction. Manual mode allowed us to determine if the simple step of having to self-identify themselves as a driver or passenger would reduce SPUWD. (3) While in **auto-detect mode**, a user could press the “Passenger Unlock” button, causing the app to start seat detection. A green rectangle helped the user orient the phone for optimal detection. If the passenger seat was detected, the app hid itself and allowed the user access to all apps. If the driver's seat was detected, the app only allowed the use of apps for navigation and emergencies (Knutson et al., 2021). See Fig. 1 for participants' view of the app and app flow in manual versus auto-detect mode. In both auto-detect and manual modes, participants were given the option to press an “emergency unlock” button to fully access their smartphone. This “emergency unlock” feature was developed to ensure that users could access their smartphones in emergency situations. Notably, the app is also linked to a web portal that allows parents to modify settings and monitor the use of the app; however, these features were not used during this study.

1.2. Objective of current study

The primary objective of the current study was to evaluate the frequency of smartphone use among young drivers and their parents while driving. More specifically, the study aimed to determine if the LifeSaver app was effective in reducing the rate of SPUWD in each of the

three different app modes. It was expected that SPUWD would be reduced by the greatest amount in the auto-detect mode of the LifeSaver app as participants did not have a choice in whether the app blocked smartphone use.

2. Materials and methods

2.1. Study design and recruitment

Participants were recruited through the Children's Hospital of Philadelphia (CHOP) pediatric healthcare network's Recruitment Enhancement Core from January 1, 2020, until May 5, 2021. The CHOP network spans over 50 locations in southeastern Pennsylvania and southern New Jersey and has over 1 million visits every year. We utilized information available in CHOP's network-wide electronic health records system to email potentially eligible families with a teen aged 16 years through 18 years. Dyads enrolled in the study were assigned a unique identification code that served to code all subsequent data collection tools. All study procedures were approved by CHOP's Institutional Review Board (IRB#:19-016717; Clinical Trial: [NCT04177524](#)).

Interested individuals contacted the research team via phone or email and were scheduled for a screening phone call with a research assistant to determine eligibility. We recruited participant dyads, which include a 16- to 18-year-old teen and their parent or caregiver. Dyads were eligible if both the teen and parent or caregiver self-reported that they use Android smartphones and drove at least two times per week. If eligible, both participants in the dyad independently completed an intake questionnaire. All questionnaires and surveys were administered via REDCap, a secure internet-based data collection tool (Harris, 2021). The intake questionnaire was emailed to the participants immediately after the screening phone call and collected information about both parent and teen participants' driving history, including date of licensure; involvement as a driver in motor vehicle crashes; traffic violations; distracted driving behavior; and SPUWD. After completing the intake questionnaire, participants received a welcome call from a research assistant in which they were randomly assigned to one of the three study arms and both parents and teens downloaded the LifeSaver app. The three study arms included different combinations of each app mode (background, manual and auto-detect mode). In arm 1, participants alternated between Manual Mode and Auto-Detect Mode every 2 weeks for a total of 4 periods. Arm 2 started with Auto-Detect Mode for 4 weeks followed by Manual Mode for 4 weeks. Arm 3 began with Background Mode for 4 weeks followed by Auto-Detect Mode for 4 weeks. Our use of a crossover design with randomized assignment to three study arms allowed for comparison of app modes within drivers, as each driver acted as their own control. See Fig. 2 for study flow.

2.2. Intervention

The eight-week intervention began once dyads installed the LifeSaver app. Dyads received four bi-weekly self-report surveys via REDCap that assessed the following behaviors over the previous two week period: the amount of driving, SPUWD, use of emergency unlock function, use of passenger unlock function, the extent to which the app incorrectly identified the user's seating position, and attempts to over-ride the app. Participants completed a final

survey via email up to 72 h (about 3 days) after their final day of the intervention portion of the study (end of week 8). This final survey assessed usability of the app, recommended changes to the app, behavior changes because of the app, and involvement in crashes and traffic violations during the study period.

The research team passively monitored each participant's interaction with the app and contacted the participant if their app was not collecting data to resolve the problem. Data collected by the LifeSaver app were automatically uploaded and saved on a secure, password protected LifeSaver administrative web portal. Participants were paid up to \$125 for completing the study, including \$25 for completion of the intake survey, \$10 for completion of each periodic survey, and \$60 for completion of the post-intervention survey. After completion of the study, dyads were sent a close-out email, which explained how to uninstall the app and where they could download a version from the app store if they would like to continue using it.

2.2.1. Data collected by the LifeSaver app: The LifeSaver app automatically collected drive time and event activities over the study period. Drive time began when the vehicle started moving (i.e., based on velocity) and ended 4 min after the vehicle stopped moving; we subtracted 4 min to determine the length of each drive for analytic purposes. Event activities were defined as the use of mobile apps including allowed apps (mapping and music apps), social media apps (e.g., Twitter and Facebook), messaging apps (e.g., texting and WhatsApp), and other potentially distracting apps. Other event activities included LifeSaver-specific detections of driver use and passenger use of the mobile device.

2.3. Analyses

We analyzed self-reported survey data and drive time/activity data from the LifeSaver app for each member of the dyad (teen and parent/caregiver) separately. We summarized total drive time, drive time for each type of app usage, and number of event activities for the four 2-week intervention periods and modes based on the driver's randomized arm. We also calculated the proportion of driving time spent using each type of app for each 2-week period. Median and interquartile ranges were used to describe the distributions of total drive time, drive time using each type of app, proportion of time using each type of app, and number of event activities for each period and mode for parents and teens separately. We compared periods and modes using Wilcoxon statistics for non-parametric data. In sensitivity analyses, we limited data to the first period only to compare all three modes without any learning effect. Additionally, we compared manual and auto-detect modes in the 4th two-week period only to account for learning over the previous three periods. Statistical analyses were conducted using SAS software, version 9.4 (SAS Institute Inc., Cary, NC).

3. Results

Out of 1,267 study inquiries, 90% were ineligible because one member of the dyad, either the parent or teen, owned an iPhone (the modified LifeSaver app is not currently supported on this platform). A total of 65 parent-teen dyads met all other eligibility criteria, completed the initial intake surveys, and were assigned to intervention arms. Four dyads dropped out during the 8-week study period (one from Arm 1, one from Arm 2 and 2 from Arm 3)

leaving a final analytic sample of 61 dyads. Parents were predominately White (85.2%), married (80.3%), female, (80.3%), and were on average 49 years old. The teen group included mostly White (85.2%), males (57.4%) who were on average 17 years old. Teen participants included those with provisional/probationary licenses (70.5%) as well as those with an unrestricted full license (29.5%). All teens were currently enrolled in high school at the time of study participation. See Table 1 for participant characteristics.

3.1. Survey findings

Overall, parents and teens had positive experiences with the LifeSaver app and felt that it made them safer drivers by reducing their mobile phone use. Over the 8-week study period, there were no significant changes in the self-reported days per week or times per day that participants reported using their SPUWD. There was, however, a significant decrease in the self-reported amount of driving for all participants over the study period. When asked to self-report their feelings about personal safety and focus while driving on a scale of 1 (not very focused/safe) to 5 (very focused/safe), all parents and teens reported either a 4 or 5 indicating that they felt “very safe” and “very focused” while driving without distractions. However, when asked about their focus and safety while talking on a smartphone while driving, most parents and teens admitted that it compromised both their focus and safety to do so. Participants also reported that their focus and safety were even further negatively impacted by sending or reading text messages on their smartphone while driving.

3.1.1. Parents

Auto-Detect Mode. While using the app in auto-detect mode, 40% of parents admitted to trying to unlock their smartphones as the driver. Of those 40%, the majority (57%) reported that the app automatically identified them as the driver and prevented them from using their smartphones. The emergency unlock button was used by 21% of parents while in auto-detect mode and was used mainly for emergency family calls or texts. Most parents (85%) reported that after pushing the “passenger unlock” button, the app “never” or “rarely” incorrectly identified them as the driver when they were in fact passengers. When asked about the accessibility of navigation apps, 70% of parents reported “often” or “always” being able to use their navigation apps while driving. Parents were overall pleased with the app, reporting that they were: “a little pleased” (17%) to “pleased” (50%) and found it “a little effective” (21%) to “effective” (50%) in reducing mobile distractions. One parent said, “I have noticed that over the last 8 weeks I am much more conscious of when I am attempting to pick up the phone while driving to the point where I am almost never picking it up now.” Another parent reported that “the [auto-detect] mode was very user friendly.”

Background Mode. While using the app in background mode, 81% of parents were “often” or “always” able to use their navigation apps when needed and were either pleased with or did not notice the app (97%). Of the parents that did notice the app, 83% found it to be at least somewhat effective in reducing their mobile phone use while driving.

Manual Mode. Compared to background mode, there were several parents who reported either neutral or displeased feelings toward the app in manual mode, but also reported that it was effective in reducing their mobile phone distraction while driving (75%). One parent

described the app in manual mode as, “a nice tool to keep in check the number of times a person checks or tries to access their phone while driving.” Another parent said, “having to press passenger unlock deterred me from checking my phone a few times when a text would come in while I was driving.”

App recommendations. When asked about using the app themselves, most parents preferred the app in auto-detect mode (64%) as compared to manual mode (36%). However, when asked about their teens using the app, a much higher percentage of parents (93%) would prefer their teen to use the app in auto-detect mode. The participants were also asked about their preference of features that may be added to the commercial version of the LifeSaver app. One new feature is the dashboard, which allows users to see information about their recent drives, emergency unlocks, and passenger unlocks. Another additional feature is the map portal, which shows information about each time a user’s phone was unlocked while driving in the past month and the location that the unlock happened. Users would also be able to link to other drivers so they can review each other’s driving information. Parent users would also be able to enable a feature where they would receive a text alert every time that the teen starts and ends a drive.

When asked about the additional dashboard, map portal and text alert features of the app, parents said that the dashboard would be very helpful for both themselves (63%) and for their teens (95%). A significant proportion of parents also thought that the map portal feature would be helpful for themselves (48%) or their teens (79%). Parents were positive in their reactions to the text alert feature, with 89% reporting that it would be “very” or “extremely” helpful and 90% said they would use the feature often. One parent commented, “I think the combination [of features] would be excellent to use with a new driver during the driver’s education to analyze their behavior...”

3.1.2. Teens

Auto-detect mode. When asked about the app in auto-detect mode, 63% of teens reported that the app was “easy” or “very easy” to use and 68% reported that it was “moderately” or “very” convenient. Most teens also reported that they never or rarely had the app incorrectly identify them as a driver when they were passengers (76%). Teens felt that parents, inexperienced drivers, young drivers, and older drivers would all benefit from using the app. When asked about how the app affected their driving, 53% of teens reported that it made them a safer driver, and 60% said it changed the way they drove. When asked about their time using the app, 26% of teens admitted to trying to avoid or trick the app so they were able to use their smartphones while driving; of those that tried, 46% succeeded by leaning and hovering the phone over the passenger seat of their vehicle. Teens did, however, find the app helpful in preventing their distracted driving. One teen said, “The auto-detect mode was very helpful in preventing me from using my phone” and another said, “...it made me feel safe from myself.” When asked what they liked least about the app in auto-detect mode, teens cited the battery use, ease of avoiding/tricking the app, and the inconvenience of having to scan to ensure they were passengers before being able to use their phones.

Background mode. When asked about the app during background mode, 21% of teens reported that the app was still a “little effective” at reducing SPUWD because they knew someone would know if they used it. Most teens (58%), however, did not notice or remember that the app was on their phone.

Manual mode. Most teens reported that the app in manual mode was “a little effective” (47%) or “effective” (21%) in reducing mobile phone distraction simply by asking teens if they were the passenger or driver before a drive. “The reminder that I was the driver was [a] deterrent to get on the phone, but it was easy to get around it,” specified one teen.

App recommendations. Overall, most teens preferred the app in auto-detect mode (54%) as compared to manual mode (46%). Teens found the suggestion of the dashboard feature to be “moderately” to “extremely” helpful and 70% said they would use it often. Most teens (78%) also thought the map portal feature would be “moderately” to “extremely” helpful, but 68% said they would “never” or “rarely” use it. One concern commonly cited by teens was the idea that parents would track their location with the map portal. One teen commented that, “teens will be less likely to use the app [with these additional features], but it will be popular with parents.”

3.2. LifeSaver app data findings

Over the 8-week period, participants took an average of 136 drives over the 8-week study period for an average of 2,086 min of driving. During that driving time, participants spent on average 4.2% of their time using allowed apps (music and navigation), almost no time in social media apps, about 1% of their time in messaging apps and 2.4% of their time using other potentially distracting apps (e.g., news apps, games). There were no significant differences in days of driving, number of drives or time spent driving recorded by the app between the three study arms. Across study arms however, parents spent significantly more time driving than their teens ($p < 0.01$). To account for this, we also examined the percentage of time spent in various apps divided by the total time driving. Looking at this metric, teens spent significantly more time in social media apps compared to parents; while parents spent significantly more time than teens using messaging and other apps. (See Table 2 for a summary of driving data for parents and teens).

Overall, there was no statistically significant reduction in smartphone use across study periods (e.g., week 2 vs. week 8) for either group. However, when looking at only the first period of the study to eliminate learning effects, parents did spend significantly more time using social media apps while the app was in background mode compared to both manual and auto-detect mode. Parents and teens also spent the greatest amount of time using apps while in background mode compared to both the auto detect and manual modes although this difference did not reach statistical significance. This implies that when the app required participants to confirm their driver/passenger status (either manually or via auto-detect) it discouraged them from using their smartphones while driving. Although the differences did not reach statistical significance, these reductions in smartphone use do provide practical significance. Even slight reductions in MPUWD can improve the safety of both parent and

teen drivers. See Table 3 for detailed driving and app usage data during the first two weeks of the study for both parents and teens, across app modes.

4. Discussion

Although the objective data collected by the Lifesaver app in the current study did not reach statistical significance, the practical and clinical significance of even small reductions in distracted driving behaviors (e.g., social media app use) is valuable. Further, the qualitative data suggests that both teen drivers and their parents are open to technologies that would prevent distracted driving. In line with our findings, many advocacy groups, and even teens themselves, are aggressively seeking to stop driver smartphone use (Pope et al., 2017). The favorable usability and acceptability scores of the Lifesaver app reported by both parents and teens are promising for the future development of distracted driving prevention technologies. Effective apps and prevention technologies can only translate into prevented injuries and fatalities if families are willing to incorporate them into their daily lives. Additionally, due to the inaccessibility of in-person education courses in rural areas of the United States, teens and parents who live in these rural communities who own smartphones would also benefit from distracted driving prevention technology (Statti & Torres, 2020).

This research is also of tremendous importance in underscoring that a family-based approach to preventing mobile phone use while driving is key. Results of the current study suggest that parents may be reluctant to change their own distracted driving behavior but would prefer that their teens not engage in that same behavior. This important finding suggests that anti-distracted driving interventions must target not only teens but also their parents or caregivers. Teens often take cues and learn behavior from their parents and may be even more reluctant to give up dangerous behaviors such as distracted driving if their parents are engaging in them on a daily basis. The LifeSaver app's family approach may also be beneficial in facilitating conversations about distracted driving between parents and teens.

There were several limitations present in this study. First, our study sample was small ($n = 61$) due to the app only being available on Android smartphones. During recruitment, many teens and parents were ineligible because they owned iPhones rather than Androids. Larger study numbers would likely show more consistent findings between objective data collected by the app and qualitative reports of parents and teens. Recruitment also took place during the COVID-19 pandemic, which likely stunted data collection and driving frequency. Participants also drove less than expected over the intervention period, which was likely due to the COVID-19 pandemic and travel/work restrictions placed on the study population's location. Second, the application does not currently distinguish between vehicle types, so trips via bus and train may not be properly recorded. Additionally, the newly developed technology needs further testing in a broader and more diverse population of parents as our sample was largely female.

As the number and variety of apps used by teens continues to rapidly increase, it is important for transportation researchers to examine how interactions with these newer apps (e.g., Snap Chat, TikTok) may impact driving safety. When using scanning or smartphone camera technology, it is also important to consider the potential of distraction if users try

to circumvent the apps phone blocking technology. Additional methods of automatically identifying trips as “driver trips” or “passenger trips” should be investigated. Future studies should include the implementation of the app on iPhones and in a larger and more diverse population to be able to generalize changes in distracted driving to all parents and teens. Encouragingly, participants in the current study did not use their smartphones while driving as frequently as reported in previous studies. This may have been in part due to selection bias—that is, participants who chose to take part in a study to help prevent distracted driving may be less likely to use phones while driving in general.

5. Conclusions

Minor changes to the app should be considered to improve its acceptability and usability among parents and teens such as the inclusion of iPhone users and the addition of apps gaining popularity among teen users (i.e., Snapchat and TikTok). Expanding the app to iPhone users would give us broader knowledge of the app’s effectiveness as most teens use iPhone smartphones. Although battery use was a complaint from both parents and teens, it is estimated that the battery use for the LifeSaver App was less than 1% per hour. The issue of battery life may have been a perception of participants rather than an app limitation. Participants were also successful at tricking the app, which reduced its effectiveness in auto-detect mode. More work may be needed to ensure that drivers are unable to get around the apps’ safeguards to prevent distracted driving. Overall, however, both the act of self-identification as a driver or passenger (manual mode) and the app automatically detecting if the user was a driver or passenger (autodetect mode) were somewhat effective in deterring parents and teens from using their smartphones while driving. Although teens are at the greatest risk for MVCs related to distracted driving, our findings suggest that a family systems approach should be used for distracted driving interventions. If parents are engaging in distracted driving behavior in front of their teens regularly, interventions targeting the teens alone are unlikely to be successful.

Note: Dr. Haley Bishop is a Clinical Research Associate I at the Center for Injury Research and Prevention at Children’s Hospital of Philadelphia. Her work focuses on identifying the psychological factors that affect the transportation safety of individuals with developmental disabilities such as autism spectrum disorder and attention-deficit hyperactivity disorder. Dr. Bishop’s research also examines how targeted, family-based interventions can impact behavior and prevent injuries among vulnerable road users such as teen drivers and child passengers.

Acknowledgement

This work was supported by the Center for Disease Control and Prevention [grant number 6R44CE002753-03-01]. The authors would like to acknowledge the contributions of Nicole Caputo, Gillian Terlecky and Adrian Diogo for writing assistance and proofreading. The authors would also like to thank LifeSaver for the use of their innovative app (<https://lifesaver-app.com>).

References

- AAA Foundation for Traffic Safety. (2021). Cell phone use while driving and crash risk: A case-crossover analysis. *Journal of Safety Research*, 77, 1–10. 10.1016/j.jsr.2021.01.001 [PubMed: 34092299]
- Berlin H, Coughenour C, Pharr JR, Bungum TJ, Manlove HA, & Shan G (2021). The impact of an educational intervention on distracted driving knowledge, attitudes, and behaviors among college students. *Journal of Community Health*, 46(6), 1236–1243. 10.1007/s10900-021-01014-y [PubMed: 34215995]
- Bingham CR, Zakrajsek JS, Almani F, Shope JT, & Sayer TB (2015). Do as I say, not as I do: Distracted driving behavior of teens and their parents. *Journal of Safety Research*, 55, 21–29. 10.1016/j.jsr.2015.07.007 [PubMed: 26683544]
- Buczek L, Gryder LK, Slinkard-Barnum S, Batra K, Trummel C, McNickle AG, Fraser DR, Kuhls DA, & Chestovich PJ (2022). Evaluating Long-Term Outcomes of a High School-Based Impaired and Distracted Driving Prevention Program. *Healthcare*, 10(3), 474. 10.3390/healthcare10030474 [PubMed: 35326951]
- Carter PM, Bingham CR, Zakrajsek JS, Shope JT, & Sayer TB (2014). Social norms and risk perception: Predictors of distracted driving behavior among novice adolescent drivers. *Journal of Adolescent Health*, 54(5), S32–S41. 10.1016/j.jadohealth.2014.01.008
- Classen S, Winter S, Brown CT, Morgan-Daniel J, Medhizadah S, & Agarwal N (2019). An Integrative Review on teen Distracted Driving for model program development. *Frontiers in Public Health*, 7, 10.3389/fpubh.2019.00111
- Delgado MK, Wanner KJ, & McDonald CC (2016). Adolescent cellphone use while driving: An overview of the literature and promising future directions for prevention. *Media and Communication*, 4(3), 79–89. 10.17645/mac.v4i3.536 [PubMed: 27695663]
- Gershon P, Zhu C, Klauer SG, Dingus T, & Simons-Morton BG (2017). Teens' distracted driving behavior: Prevalence and predictors. *Journal of Safety Research*, 63, 157–161. 10.1016/j.jsr.2017.10.002 [PubMed: 29203014]
- Hafetz J, Jacobsohn L, Garcia-Espana JF, Curry AE, & Winston FK (2010). Adolescent drivers' perceptions of the advantages and disadvantages of abstention from in-vehicle cell phone use. *Accident Analysis & Prevention*, 42(6), 1570–1576. 10.1016/j.aap.2010.03.015 [PubMed: 20728605]
- Knutson M, Kramer K, Seifert SM, & Chamberlain R (2021). Automatically identifying a mobile phone user's position within a vehicle. *arXiv (Cornell University)*. doi: 10.48550/arxiv.2111.06306.
- LaVoie N, Lee Y, & Parker J (2016). Preliminary research developing a theory of cell phone distraction and social relationships. *Accident Analysis & Prevention*, 86, 155–160. 10.1016/j.aap.2015.10.023 [PubMed: 26562672]
- McDonald CC, & Sommers MS (2015). Teen drivers' perceptions of inattention and cell phone use while driving. *Traffic Injury Prevention*, 16, S52–S58. doi: 10.1080/15389588.2015.1062886. [PubMed: 26436243]
- Pope CN, Bell T, & Stavrinou D (2017). Mechanisms behind distracted driving behavior: The role of age and executive function in the engagement of distracted driving. *Accident Analysis & Prevention*, 98, 123–129. 10.1016/j.aap.2016.09.030 [PubMed: 27716494]
- Porter G (2010). Alleviating the “dark side” of smart phone use. *IEEE International Symposium on Technology and Society*. 10.1109/istas.2010.5514609
- Pradhan AK, Hammel KR, DeRamus R, Pollatsek A, Noyce DA, & Fisher DL (2005). Using Eye Movements To Evaluate Effects of Driver Age on Risk Perception in a Driving Simulator. *Human Factors*, 47(4), 840–852. 10.1518/001872005775570961 [PubMed: 16553070]
- Salay R, Czarnecki K, Kuwajima H, Yasuoka H, Nakae T, Abdelzad V, Huang C, Kahn M, & Nguyen VH (2021). The missing link: Developing a safety case for perception components in automated driving. *arXiv (Cornell University)*. doi: 10.48550/arxiv.2108.13294.

- Schmidt S, Morrongiello BA, & Colwell SR (2014). Evaluating a model linking assessed parent factors to four domains of youth risky driving. *Accident Analysis & Prevention*, 69, 40–50. 10.1016/j.aap.2013.08.028 [PubMed: 24797085]
- Statti A, & Torres KM (2020). The Forgotten Minority: Exploring deficiencies in access to education and technology in rural America. *Peabody Journal of Education*, 95(2), 173–182. 10.1080/0161956x.2020.1745608
- Stavrinos D, McManus B, & Beck H (2020). Demographic, driving experience, and psychosocial predictors of adolescent distracted driving beliefs. *Accident Analysis & Prevention*, 144, Article 105678. 10.1016/j.aap.2020.105678
- Vaterlaus JM, Aylward A, Tarabochia DS, & Martin JD (2021). “A smartphone made my life easier”: An exploratory study on age of adolescent smartphone acquisition and well-being. *Computers in Human Behavior*, 114, 106563. doi: 10.1016/j.chb.2020.106563.
- White KM, Hyde MK, Walsh SP, & Watson BC (2010). Mobile phone use while driving: An investigation of the beliefs influencing drivers’ hands-free and hand-held mobile phone use. *Transportation Research Part F-traffic Psychology and Behaviour*, 13 (1), 9–20. 10.1016/j.trf.2009.09.004



Fig. 1. An overview of the LifeSaver app flow in manual mode (left) and auto-detect mode (right). In the manual mode flow (left), screen 2 would appear if the user selected that they were a passenger. In the auto-detect flow (right), screen 3 would appear if the app determined that user was a passenger and screen 4 would appear if the app determined that the user was the driver.

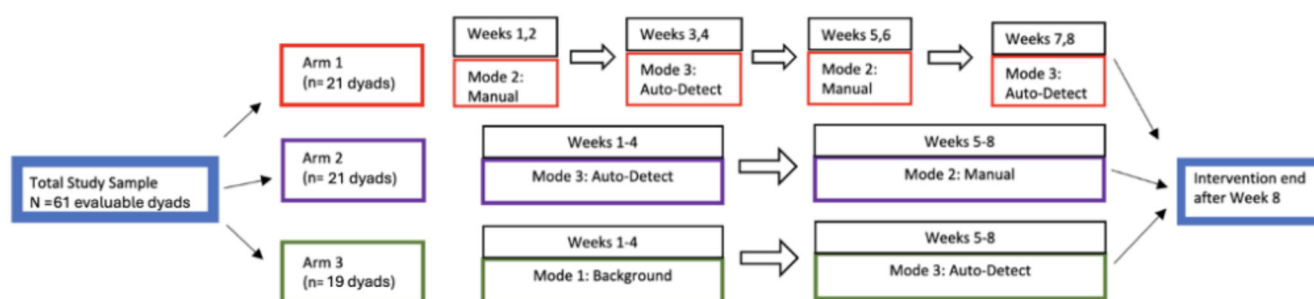


Fig. 2.

An overview of participant flow through the study in each of the three study arms.

Table 1

Participant Characteristics.

	Parent Group N = 61	Teen Group N = 59
Age, years <i>Mean (standard deviation)</i>	49 (6.9)	17 (0.6)
Sex n(%)		
Female	49 (80.3)	26 (42.6)
Race n(%)		
White	50 (82.0)	52 (85.2)
Black	3 (4.9)	4 (6.6)
Other	8 (13.1)	5 (8.2)
Ethnicity n(%)		
Non-Hispanic	58 (95.1)	59 (96.7)
Education		
Some high school	1 (1.6%)	61 (100%)
High school diploma or GED	3 (4.9%)	–
Some college	7 (11.5%)	–
Associate degree	5 (8.2%)	–
Bachelor's degree	30 (49.2%)	–
Master's degree or higher	15 (25%)	–
Marital Status n (%)		
Married	49 (80.3%)	–
Divorced	8 (13.1%)	–
Never Married/Widowed/Separated	4 (6.6%)	61 (100%)

Table 2

Summary of Parent and Teen Driving and App Usage Data Across Study Arms and Periods.

Variable	P	Total		Parent		Teen	
		N	Median	N	Median	N	Median
Number of days of driving	0.03	120	32	61	37	59	27
Number of drives	0.001	120	136	61	170	59	110
Time driving (minutes)	0.004	120	2086.2	61	2330.2	59	1121.1
Time using map apps (minutes)	0.009	120	38.7	61	84.6	59	15.1
Time using social media apps (minutes)	0.06	120	0.5	61	0	59	3.1
Time using messaging apps (minutes)	<0.001	120	6.9	61	17.2	59	2
Time using other apps (minutes)	0.004	120	39.2	61	73.8	59	22.6
% of time using map apps divided by total time driving	0.06	120	1.9	61	3.7	59	1.1
% of time using social media apps divided by total time driving	0.02	120	0	61	0	59	0.3
% of time using messaging apps divided by total time driving	<0.001	120	0.4	61	0.8	59	0.2
% of time using other apps divided by total time driving	0.02	120	2.4	61	3.2	59	1.5

Table 3

Driving and app usage data from the first 2-week period of the study.

Teens	Auto						Background						Manual					
	P	N	Median	Q1	Q3	N	Median	Q1	Q3	N	Median	Q1	Q3	N	Median	Q1	Q3	
Number of days of driving	0.4	21	7	5	12	17	11	6	12	21	9	5	13					
Number of drives	0.18	21	28	18	34	17	34	22	62	21	29	21	56					
Time driving (minutes)	0.55	21	375.6	228.7	697.4	17	502.7	215.9	1001.3	21	349.1	142.1	905					
Time using social media apps (minutes)	0.29	21	0	0	8.7	17	10.2	0	22.2	21	0	0	1.4					
Time using messaging apps (minutes)	0.59	21	0	0	0.2	17	0	0	2.4	21	0	0	3.9					
Time using other apps (minutes)	0.23	21	0.9	0	15.9	17	16.8	0	35.9	21	9.5	0.3	42.1					
% of time using social media apps divided by total time driving	0.3	21	0	0	1.8	17	1	0	3	21	0	0	0.4					
% of time using messaging apps divided by total time driving	0.59	21	0	0	0	17	0	0	0.2	21	0	0	0.8					
% of time using other apps divided by total time driving	0.27	21	0.4	0	2.5	17	1.1	0	4.6	21	1	0.2	9.7					
Parents	Auto						Background						Manual					
	P	N	Median	Q1	Q3	N	Median	Q1	Q3	N	Median	Q1	Q3	N	Median	Q1	Q3	
	0.93	21	12	7	13	19	10	8	13	21	12	8	12					
	0.89	21	47	33	64	19	53	29	61	21	48	35	65					
	1	21	693.3	472	997.6	19	706.7	452.5	946	21	630.9	379.8	859.3					
	0.05	21	0	0	0	19	0	0	6.8	21	0	0	0					
	0.24	21	1.8	0	7.3	19	7.9	0	25.8	21	2	0	3					
	0.55	21	22.9	0	42.9	19	35.3	1.4	116.9	21	6.8	2.4	79.1					
	0.06	21	0	0	0	19	0	0	0.6	21	0	0	0					
	0.3	21	0.3	0	1.1	19	0.6	0	4.6	21	0.3	0	1.1					
% of time using other apps divided by total time driving	0.55	21	3.9	0	5.9	19	5	0.2	22.3	21	2	0.5	8.5					