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Effectiveness of Parent-Focused Interventions to Increase Teen Driver Safety:A Critical Review

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Abstract

Purpose—We critically reviewed recent parent-directed teen driving interventions in order to summarize their success in meeting stated goals; identify promising intervention components and knowledge gaps; aid in the selection, adaptation, and dissemination of effective interventions; and guide future research efforts.

Methods—We focused on interventions that included a direct parent component, explicitly stated outcomes related to the teen and/or their parents, were evaluated for parent or teen outcomes, targeted drivers under age 21, and had at least one evaluation study published since 1990 and in English. We conducted a comprehensive systematic search of 26 online databases between November 2013 and January 2014 and identified 34 papers representing 18 interventions.

Results—Several interventions—in particular those that had an active engagement component, incorporated an in-vehicle data recorder system, and had a strong conceptual approach—show promise in improving parental supervisory behaviors during the learner and early independent phases, increasing teen driver skill acquisition, and reducing teens' risky driving behaviors.

Conclusions—We identify essential characteristics of effective parent-involved teen driving interventions and their evaluation studies, propose a comprehensive and multi-tiered approach to intervention, and discuss several research areas and overarching issues for consideration.

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Keywords

Adolescent; Graduated Driver Licensing (GDL); Motor vehicle crash; Novice driver restrictions; Parent-teen interactions; Supervised practice driving; Teen driver programs

Parents strongly influence their children's development. In general, involved parents who are responsive (i.e., warm, accepting), set developmentally appropriate behavioral limits, and avoid harsh discipline and psychologically controlling behaviors (e.g., guilt induction) positively affect development [1-5]. Parent-focused programs and interventions can foster positive child development by targeting factors such as parenting skills, beliefs, and practices [2,6-8].

Due to the individual and societal burden of motor vehicle crashes among teenagers, a growing body of research seeks to explain the mechanisms by which parents influence teenagers' driving behaviors and to modify these influences via a myriad of intervention approaches [9,10]. Akin to other domains of development, research with young drivers and their parents has demonstrated the importance of shared genetic and environmental factors (e.g., home safety climate, neighborhood), parental knowledge and modeling of behavior, parenting style, and monitoring of teens' driving behaviors [11-19]. However, research has shown gaps in parent success in this role as well as in our knowledge about specific parent attributes and parent-teen interactions that have the most beneficial effect on teen drivers' safety [20]. Parents generally exhibit poor monitoring and control of teens' risky driving behaviors, often fail to clearly define driving rules and expectations [13,21-23], have varying levels of engagement in helping their teens mature to independent drivers, and face challenges in knowing how to promote safe, skilled driving [24-27].

Given increases in research activity and parent-directed interventions, a focused synthesis of these efforts would aid in the selection, adaptation, and dissemination of effective interventions and guide future research efforts. Thus, we describe and critically review recent parent-directed teen driving interventions to summarize their success in meeting stated goals, identify the most promising intervention components and knowledge gaps, provide guidance on research needs, and inform the development of future interventions.

Methods

This review focused on teen driving-related interventions that included a direct parent component and at least one outcome related to the teen driver and/or their parent that was explicitly stated and measured. Further, interventions had to target drivers under age 21 and have at least one evaluation study available since 1990 and in English. We did not select studies based on how they defined “parent”; studies used a range of inclusion criteria and definitions. To identify interventions, a comprehensive systematic search of peer-reviewed and grey literature in 26 online databases was conducted by an experienced information specialist (see Appendix A for details). Searches occurred November 2013–January 2014. A total of 219 studies were identified and reviewed independently by three study authors (CP, AC, CH) to ensure they met inclusion criteria; eight disagreements were resolved by consensus of the three reviewers. Thirty-one papers representing 15 interventions met

inclusion criteria. Interventions that were evaluated on process outcomes such as feasibility and/or acceptability but to our knowledge were not evaluated on impact or outcomes were not included in this review [28-30].

The qualifying 15 interventions were categorized by approach: (1) passively disseminated media (print, online, and/or video) with no or minimal direct parent engagement; (2) disseminated media and directly engaged parents (via phone, web, in-person); and (3) utilized an in-vehicle data recorder (IVDR). We provide a brief description of each intervention (see also Table 1) and summarize the collective knowledge gained from evaluation of these interventions with the goal of identifying characteristics associated with effectiveness and providing direction to further intervention development.

Results

Interventions involving passive dissemination of media

Five interventions (accounting for 13 published papers) delivered content via video, print, online, or a combination of these with no or minimal direct engagement of parents (other than during recruitment and/or data collection activities).

Checkpoints—The *Checkpoints* program—the most widely evaluated parent-directed teen driving intervention—is guided by social learning theory and protection motivation theory [11,31-38]. *Checkpoints* aims to increase parental restriction of high-risk driving conditions among novice teen drivers by altering parental attitudes, perceptions, and expectations around managing driving restrictions through persuasive messages and a parent-teen driving agreement (PTDA). An early RCT (n=469) and subsequent statewide trial (n=4,344) in Connecticut recruited teens and parents at licensing centers at the time of the learner's permit; in both studies, a very high percentage (>90%) of eligible families agreed to participate. A series of educational materials were mailed to intervention families, including a PTDA just before licensure; most parents reported receiving and using intervention materials. Although the same proportion of intervention and comparison parents reported completing a PTDA (44%), intervention parents were four times more likely than comparison parents to be using the PTDA at 3 months post-licensure [35]. In general, intervention parents reported higher levels of restriction of high-risk driving conditions at licensure and 3 months post-licensure [32]. However, effects were modest, in some cases did not differ for peer passenger or weekday night restrictions, and generally decayed over the first year of licensure [35], although a weakening of effects may be consistent with the *Checkpoints* recommendation of a gradual relaxation of limits over time. The statewide trial had similar outcomes and identified parents' perceived risk and expectations at licensure as important mediators [31,38]. Adjusted models found no effect of the intervention on teen-reported crashes at three months post-licensure (OR=0.98, 95% CI: 0.82, 1.19) and a negative association with traffic violations at six months post-licensure (OR=0.81 [0.67, 0.99]), but not at three or twelve months [37,38].

Tennessee Novice Driver Safety Project—Chaudhary et al. evaluated an intervention implemented by the Tennessee Department of Transportation which aimed to increase parental involvement in the learning-to-drive process and parental restrictions in the

intermediate stage [39]. Parents of teens with learner's permits were assigned (no indication of randomization) to receive a mailed: (1) motivational letter and instructional booklet that provided guidance to parents on supervising practice; (2) welcome letter, instructional booklet, and series of informational cards; or (3) welcome letter with general advice for parents about supervising their teen's practice. Post-licensure telephone surveys were conducted but no overall response rate provided. Although the majority of intervention group participants remembered receiving materials, very few could identify the content. The intervention had no discernable effect on parent-reported supervisory practice behaviors (e.g., planning), use of PTDA's, or teen crashes or citations.

Parental Supervision of Teenage Drivers in GDL—Goodwin et al. evaluated an enhanced version of the Tennessee intervention in which parents received material directly from North Carolina licensing center personnel rather than by mail [40]. An additional intervention arm involved condensing the booklet into a series of three “tip sheets,” one distributed at recruitment and two subsequently mailed. Eighty percent of parents remembered receiving the booklet compared with only half who remembered the tip sheets. Although 62% of parents who remembered receiving materials reported using them to guide supervision, there were no differences between the groups in supervisory behaviors.

Court-directed Parent Involvement Program—Mattox evaluated a court-based program for young drivers with traffic violations that aimed to increase parental monitoring and reduce recidivism (subsequent violations) [41]. Intervention parents received an “informational safety packet” by a court officer during the citation hearing. Recidivism was lower for intervention females (8% vs 34% of controls) but not intervention males (25% in the both groups).

Parent-teen Driving Agreement—Lichenstein et al. provided teens with a PTDA to take home from school and complete with parents [42]. Given low response rates to follow-up surveys (3%) and lack of a comparison group, valid conclusions about program impact could not be made.

Summary—Passively disseminating material had little effect on parental behaviors. *Checkpoints* was the exception, perhaps because it was theoretically grounded and had multiple contact points. Although the program had a modest effect on certain parental restrictions and teen-reported risky driving in the first few months of licensure, there was no discernable reduction of crashes. Although this general approach is widely scalable, the impact of interventions using this approach is likely to be low.

Interventions involving dissemination of media and direct parent engagement

Six interventions (accounting for 12 published papers) delivered content via video, print, online, or a combination of these and directly engaged parents.

Adapted Checkpoints—The *Checkpoints* program was adapted into a 30-minute in-person parent and teen driver education session [43,44]. The program consists of videos, persuasive messages, facilitated discussion, and dedicated time to complete a PTDA.

Compared with controls, intervention teens reported more PTDA use at licensure (13% vs. 73%, respectively), greater passenger restrictions (OR: 8.52, $p<.01$), and less high-risk driving at six months post-licensure [43]. No differences were found for crash involvement (intervention: 12%, control: 9%) or being stopped by a police officer while driving.

TeenDrivingPlan was a web-based program for parents of permit holders with three core components: (1) brief videos on how to structure practice activities across a variety of driving environments; (2) an interactive web-based planner to promote supervised driving; and (3) logging and rating of practice hours and driving behaviors [24, 45-47]. The intervention draws from several theoretical frameworks, including the Integrative Model of Behavior Change [48], and was designed to increase the quantity, quality, and variety of supervised practice. For evaluation, teen-parent dyads were randomized to the intervention or a control group; groups were compared using an on-road driving assessment ($n=151$) conducted by blinded driving evaluators at 24 weeks post-enrollment. For each three-week study period, if families did not meet log-in requirements they received a call from study administrators to encourage TDP use and to provide technical support. Intervention families logged into TeenDrivingPlan a median (IQR) of 11 times (5-21) over the study period and reported greater practice than controls in 5 out of 6 environments. Intervention teens were less likely than controls to fail their assessment (6% vs. 15%; hazard ratio: 0.35 [0.12, 1.03]); log-rank $p=0.05$) [46].

Steering Teens Safe aimed to teach parents communication skills and provide instruction on supervised driving in order to help them motivate their teens to make safe driving decisions. Evaluation measures included teen-reported parent communication quality and quantity as well as risky driving [49,50]. Intervention parents received a 45-minute in-person session on motivational interviewing techniques to use with their teens, supported by a workbook, DVD, and pocket guide. Three monthly follow-up calls to discuss progress and barriers were conducted. Intervention teens reported a higher quality of parent communication than controls and had a non-significant 21% (95% CI: 0.55, 1.15) reduction in self-reported risky driving. Further, intervention teens that reported higher communication scores (i.e., above median) had a 42% (95% CI: 0.36, 0.94) reduction in risky driving compared with controls with lower communication scores [49].

Greenlight for Life included a 45-minute home visit by a trained facilitator prior to the three-month accompanied driving period (ADP) that follows entry into the independent license stage of GDL in Israel [51,52]. The visit entailed in-person instruction, educational booklets, and a CD and focused on high quality and quantity supervised driving, a PTDA, and instruction on teaching hazard recognition skills. The program's rationale was that increased quantity and quality of supervised driving would result in lower crash involvement. Greenlight participants perceived the ADP to be more useful than non-participants and had injury crash rates in the first 24 months after licensure that were 11% lower than non-participants ($p<0.01$) [51,52], although the lack of random assignment calls into question whether the estimated intervention effect is valid to the larger population of interest.

Supporting a Teen's Effective Entry to the Roadway (STEER)—This pilot study had a multiple-baseline design and included seven families of 16- and 17-year-old drivers

with Attention-Deficit/Hyperactivity Disorder (ADHD). STEER was the most intensive of all interventions reviewed, with two 45 minute in-home sessions per week for 8 weeks [53]. Despite the intervention's intensity, there was high participant retention and parents responded favorably. Preliminary outcomes on teens' driving behaviors were measured via an IVDR system and teen surveys and were suggestive of treatment effects.

Safe Drivers Wanted was embedded within a larger, multi-year social development program that began in elementary school in high-risk communities [54]. Two 90-minute in-home sessions were conducted with families—one as teens reached driving age and a second after licensure. Lessons targeted teens' decision-making skills with respect to driving, knowledge of driving laws and appropriate home-based restrictions, development of a PTDA, and interpersonal communication strategies. The authors theorized that exposure to the program would reduce impulsivity, negative peer influences, and driving under the influence of alcohol and drugs. A large majority of eligible families completed the required sessions. Compared with control teens, intervention teens had an increased odds of reporting that they had a written PTDA (OR=4.98 [2.19, 11.31]) and lower odds of driving under the influence of alcohol (OR=0.57 [0.33, 0.96]) [54].

Summary—In contrast to interventions that involved solely passive dissemination of informational material, several of these interventions demonstrated effects on parents' behaviors and teen drivers' skill acquisition and reductions of risky driving behaviors. The direct and ongoing parent engagement is an advantage, but this approach adds cost and reduces scalability.

Interventions that utilize IVDRs

Four interventions (evaluated in 6 papers) utilized in-vehicle data recorders (IVDRs) to objectively capture real-time driving “events” and provide objective information about the quality of teens' driving performance to the teens and/or their parents.

IVDR—Farmer and McCartt et al. evaluated an IVDR system by randomizing 85 novice teen drivers to a control group or to one of three arms which differed in how parents and teens were notified of driving events: (1) real-time alert with immediate parent website notification; (2) realtime alert but delayed parent website notification to allow the teen time to correct the error; (3) immediate parent website notification only [55,56]. Teens reported not liking the alerts and drowning them out by turning up the radio. Parent engagement was measured by frequency of using the website, which was highly variable with a substantial drop after one month. Results on different measured driving outcomes (seat belt use, sudden breaking/acceleration, speeding) were mixed and notably the ‘real-time alert with delayed parent notification’ intervention appeared to be insufficient to change teens' behavior. The authors also reported substantial technical difficulties which limited their evaluation.

DriveCam—Researchers used a before-after design with 26 parent-teen dyads (no external control group) to evaluate the use of DriveCam, an event-triggered video system [57,58]. A no-feedback baseline phase (9 weeks) was followed by the intervention phase (40 weeks), which included immediate feedback in the form of a blinking LED and a weekly report card

sent to parents with video clips of their teen's driving errors and information comparing the teen's performance to a peer standard. The majority of teens had low event rates (≈ 2.0 events per 1,000 miles) that remained stable throughout the baseline and entire intervention phase. Conversely, teens who initially had high event rates ($n=7$) experienced a 72% reduction (average of 23.4 to 6.4 events per 1,000 miles) over the first nine intervention weeks and an additional 89% reduction to 2.6 events over the next nine weeks. A second study found a 61% reduction ($p<0.01$) in the event rate over the intervention phase (following a 6-week baseline). On surveys, 39% of teens reported reviewing all of their safety events with at least one parent and 67% reported having a driving-related conversation with their parents.

DriveCam for Families Program—This intervention used DriveCam—the same technology described in the previous section—installed in 90 vehicles [59]. Teens were randomized to immediate in-car feedback only (Lights Only) or immediate in-car feedback plus family web access to event videos with a ranking of the teen relative to other teen drivers (Lights Plus). Participants were followed for 2 weeks of baseline and 13 weeks of intervention. Recorded event rates decreased significantly for the Lights Plus groups ($p<0.01$), while the Lights Only group showed no reduction ($p=0.67$, effect size=1.67). Forty-one of 45 parents logged in at least once, although the frequency of log-ins reduced substantially over the study period.

Greenroad—GreenRoad's IVDR system was evaluated in a study of 242 families of male young drivers with less than 1.5 months of driving experience [60]. Groups were randomly allocated to a control group or one of three intervention arms that included a combination of real-time feedback through an LED display, web-based monthly driving reports to parents, and a 90-minute parent training session to encourage monitoring and feedback to teens about driving. Only those families with parent training and the IVDR system had positive results, and only when compared with the control group. Results of this study—the only IVDR-related study to include parent training—suggest that installing an IVDR system with no parent feedback may not be effective.

Summary—Interventions utilizing IVDR systems aim to increase parents' and teens' knowledge of teens' driving behaviors via immediate or delayed information to teens and/or parents. An advantage of this approach is that it can provide immediate feedback on driving performance to the teen and objective information for parents. Interestingly, most studies did not actively instruct parents how to use this information. Reported acceptance of these systems is mixed; some studies have reported that parents and teens consider these systems to violate trust [61,62], while these evaluation studies reported that parents found them helpful. Conflicting perceptions between participants and those who chose not to participate may be an indication of selection bias—that is, it may be that only those families who do not perceive these as an invasion of privacy (or those who do not care if they violated privacy) were willing to participate in intervention trials.

Discussion

The interventions we reviewed were designed to improve teen driver safety by targeting parents and included intervention content directed towards parents' cognitions (e.g., knowledge, attitudes, beliefs), behaviors, and skills. Several interventions demonstrated improved parental supervisory behaviors during the learner stage (e.g., practice engagement; parent-teen communication) and early independent stage (e.g., limit setting), increased teen driver skill acquisition and reductions in teen risky driving behaviors. Interventions that targeted the parent-teen dyad, provided parents with concrete tools (e.g., weekly report cards, logging and rating tools) had ongoing or direct parent engagement, and had a strong conceptual approach were the most successful. The extent to which parent-directed teen driving interventions should be expected to realize a reduction in teens' motor vehicle crashes is unclear. Multiple interactive factors contribute to teens' crash involvement; it is unknown if intervening with parents in isolation from other preventive measures is enough to affect crash likelihood. Only a few of reviewed interventions were evaluated for an effect on crash risk; those that used an RCT design did not demonstrate evidence of an effect, while the one intervention that was associated with crash reduction, Greenlight for Life, was not evaluated in a RCT.

Parent-directed teen driving interventions should undergo rigorous process and outcome evaluations (and ideally be subjected to peer review) prior to widespread dissemination; many state-level interventions have been widely without being subject to such evaluation [63]. There is also substantial room for improvement in the rigor of evaluation studies of parent-directed teen driving interventions. Implementation quality or underlying theoretical constructs of reviewed studies were not routinely assessed. Without this information, it cannot be determined whether null results are attributable to implementation failure, "theory" failure, or both. With respect to the analytical approach, many studies did not estimate epidemiologic measures of effect (and corresponding confidence intervals) and instead relied on statistical thresholding, making it difficult to assess the potential for real-world impact of any one intervention and subsequently the merit of targeting a particular parenting construct. Additionally, there was a lack of longitudinal analyses when warranted (e.g., composite scores were created, data were analyzed for time points independently) and lack of adherence to evaluation guidelines, such as the Consolidated Standards of Reporting Trials (CONSORT) statement, which outlines the minimum set of recommendations for reporting randomized trials [64]. Most studies did not examine interactions between group and potentially important individual difference variables—likely due to sample size constraints—that could have provided vital information about the utility of the intervention for parents and teens of varying levels of risk. Likely due to cost and practical constraints, replication studies were extremely rare. In an effort to provide concrete guidance to future efforts, Table 2 lists essential characteristics of effective parent-directed teen driving interventions and the studies that evaluate them.

Methodological considerations

Other important methodological considerations of the reviewed studies are described below.

Intervention intensity and approach—Frequency of parent contact ranged from one-time passive dissemination of materials without active parent contact to more intensive interventions which included phone calls or in-person sessions. One advantage of in-person interventions is their ability to be individually tailored to teach specific skills, although to a certain extent this may also be accomplished via interactive web-based or mobile interventions that take advantage of user history data. In-person interventions may better ensure uptake and/or completion of intervention materials. This point is illustrated by comparing two implementations of *Checkpoints* [31,32]; both recruited through licensing offices at the time of licensure, but reports of completion were higher when the agreement was provided to families at the time of recruitment at a licensing center than when the agreement was mailed. On the other hand, more intensive in-person interventions may require trainer fidelity and be too costly and resource intensive to disseminate broadly, and thus may be most appropriate for selected or indicated populations (e.g., high-risk teens) and for agencies that have adequate resources. Notably, although the process of installing the camera in the teen's car provides an opportunity for in-person parent engagement, only one IVDR-related intervention incorporated an in-person component [60].

Evaluations of TeenDrivingPlan and *Checkpoints* have reported positive effects on parent and teen psychological and behavioral outcomes even in the absence of in-person engagement, suggesting this component may not be essential for all behavioral outcomes [31,32,45]. The effectiveness of *Checkpoints* large-scale implementation on parents' short-term limit setting also suggests that interventions may affect parental behaviors without any active parental engagement; however, it remains unclear whether parent-focused interventions can increase the safety of teens' driving behavior without this element. Finally, there is rather strong evidence to suggest that interventions that do not actively engage parents and involve passive dissemination of informational materials via one or two mailings are ineffective.

Recruitment and retention—The majority of studies recruited parent-teen dyads, usually a teen with one parent, at a range of locations (e.g., Department of Motor Vehicle offices, high schools, driver education programs, pediatric care network). Recruitment was identified as a challenge in most studies. The majority of studies used passive recruitment and studies that reported numbers of eligible participants suggest that passive recruitment leads to low participation. For example, McCartt et al. distributed 1,381 flyers that led to 108 calls from interested participants and 42 enrollments [56]. However, *Checkpoints* had participation rates of nearly 90% [31]. Their success may have been positively influenced by a close relationship with the licensing offices where staff recruited participants on-site and/or low study demands. In general, low participation increases the potential for selection bias (addressed subsequently), an important threat to study validity.

Although recruitment was almost universally challenging, study retention tended to be high; a promising finding given the intensity of some interventions. However, approximately half of longitudinal evaluations did not provide specific information about loss to follow-up despite the fact that this is a required element in standardized evaluation trial reporting [64].

Selection bias and external validity are primary concerns for this collective body of work. As most evaluation studies used convenience sampling, they may be drawing from more motivated families who already prioritize safe driving and thus are more likely to successfully implement interventions. Additionally, the majority of participating families were reported to be non-Hispanic white and have middle to upper household income. Several studies had participation criteria that excluded some families; for example, certain evaluations of IVDR-related interventions required teens to have primary access to a vehicle [45,55,56]. For these reasons, findings may not be generalizable to the larger populations of parents and teens or to specific subgroups (e.g., teens gaining driving experience at slower rates or with specific challenges). On one hand, if participants are more likely to engage with the intervention, this may translate into stronger positive effects than those that would have been observed in hypothetical “non-participants”. Conversely, if participating families are already higher functioning (i.e., less room to change), it may be more difficult and require larger sample sizes to demonstrate intervention effectiveness than would be needed if higher-risk participants were targeted. It will be important to determine whether findings of reviewed evaluation studies—which largely measure program *efficacy* under relatively ideal conditions—are realized when interventions are evaluated for *effectiveness* under more “real-world” conditions.

Future Considerations

A comprehensive program that guides families through the entirety of the licensing process and integrates psycho-educational, environmental, and policy approaches would likely be stronger than an isolated program that includes a single approach and/or focuses on a narrow time period. To develop such programs, additional research and thought in several priority areas is needed; we elaborate on these below based on the evaluation results reviewed in this paper. We acknowledge, however, that additional interventions exist that did not have evaluation findings. We strongly encourage that evaluation studies be conducted for all interventions, both to help identify individual study effects and to help identify how interventions may fit together in a more comprehensive approach.

(1) Timing—If the primary goal is to create safety-conscious, attentive drivers, efforts to instill safety as a priority might be more effective if they began earlier [65,66]. Safer teen driving may be more efficiently promoted if road traffic safety is already part of the family culture. Research suggests that parents' and teens' perceptions about parental supervision of teen drivers are strongly influenced by historical parenting patterns [15] and that the family climate around road safety is associated with driving behaviors of teen drivers[67]. Attempts to foster adoption of effective parent-teen communication skills and safety positive traffic safety cultures earlier in development might facilitate the learning-to-drive process later in adolescence. Similar strategies have been successful for preventing other adolescent risk behaviors including sexual health and drinking behavior [68-71]. Indeed, early intervention at school-, community-, and parent- levels can reap rewards across the developmental continuum [72-78]. More rigorous studies on this topic are needed to apply the learnings from other behavioral and psychological domains to research with teen drivers.

(2) Universal, Selective, and Indicated Interventions—While all parents should have easy access to guidance in supporting the development of their teen to become a safe driver, some families may need more guidance than others, and some may need more specific or tailored guidance. Only three interventions—the Court-directed Parent Involvement Program, STEER, and Safe Drivers Wanted—specifically targeted high-risk youth and families. Continuing research is needed to ascertain the need for and potential mechanisms for tailoring the learning-to-drive process to, and ensure safe driving behaviors among, high-risk teens.

(3) Diversity and Generalizability—Bias towards inclusion of higher-educated and higher-resource families in existing evaluations indicates that programs and marketing strategies able to reach different audiences, such as non-English speaking, those who do not prioritize safety, and families with low literacy, are needed. Researchers should aim to recruit samples that allow for analyses to assess whether impacts differ among driver subgroups (e.g., gender, race/ethnicity).

(4) Scalability and Sustainability—The differential impact of implementing effective interventions via voluntary engagement vs. policy/mandates (e.g., parent component of Driver's Education) should be thoughtfully considered. While some programs are widely scalable to a general audience, others are costly and difficult to scale broadly and some of these approaches, such as the use of IVDRs, may be best implemented for high-risk teens. Direct parent engagement is comparatively costly and difficult to scale, but increased use of new technologies could be helpful in tailoring information to families based on needs. An advantage of web-based programs is the ability to reach a large audience with a relatively small expense, thus making these programs more scalable to a larger audience than interventions that require expensive equipment or in-person contact. Notably, however, there is a relationship between the frequency and intensity of the intervention and the strength of the effect. One-time informational programs—arguably the most scalable—appear to have the lowest effectiveness. Future research is needed to identify the required intervention intensity.

(5) Efficacy vs. Effectiveness Research—Although study retention was high, parent engagement and success in carrying out the recommended intervention components was highly variable and often low. Most evaluations were conducted in the context of a researcher-led study as opposed to a demonstration project or real-world setting, making it difficult to understand how programs would function in the absence of evaluation or in less than ideal contexts.

Conclusion

Several parent-focused teen driving interventions have demonstrated improved parental supervisory behaviors, increased teen driver skill acquisition, and reductions in teen risky driving behaviors, which is encouraging. Although no intervention has concretely demonstrated a reduction on teen crashes and resultant injuries—the long-term public health outcome of interest—we have reason to be optimistic that long-term impact follows the measured outcomes of these evaluated interventions, in particular for interventions which

are evidence-based, theoretically informed, methodologically sound, and rigorously evaluated. Collective knowledge learned from the parent-directed teen driving interventions reviewed in this study—coupled with discussion of components critical to a successful intervention and rigorous evaluation and consideration of more holistic and comprehensive approaches—provides a roadmap for future intervention and evaluation efforts.

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Appendix A. Databases and online sources included in systematic search for teen driving-related interventions

Boolean search string

("teen*" OR "adolescent" OR "novice" OR "learner" OR "pre-teen" OR "permit" OR "young" OR "child*") AND "driv*" AND "parent*" AND ("intervention" OR "evaluation")

Databases

- CINAHL
- EBSCOhost
- ERIC and Family Studies Abstracts in EBSCOhost
- Global Health; Health Star
- ISI/Web of Knowledge/Web of Science
- LexisNexis Academic
- PsycInfo
- PubMed
- Research and Innovative Technology Administration
- SafetyLit
- Scopus
- SIGLE
- Transport Research Portal
- TRID: TRIS Online & International Transport Research Documentation
- UK Department for Transport Research Database

Online sources

- Federal Office of Road Safety, Western Australia web site
- Google
- Google Scholar
- Insurance Institute for Highway Safety
- Land Transport Safety Authority, New Zealand
- National Highway Traffic Safety Administration (teen drivers and new drivers sections)
- Swedish Transport Administration
- Traffic Injury Research Foundation, Canada (young drivers section)
- Transport Research Laboratory
- Transport Research Board
- Association for the Advancement of Automotive Medicine conference proceedings

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List of abbreviations

ADHD	Attention-Deficit/Hyperactivity Disorder
ADP	accompanied driving period
IVDR	in-vehicle data recorder
PTDA	parent-teen driving agreement

Implications and Contributions

To inform development of parent-involved teen driving interventions and promote methodological rigor of corresponding evaluation studies, we identify successes and challenges in intervention approach, recruitment/retention, and participant selection, propose a set of essential intervention and evaluation characteristics, and discuss areas of research and overarching issues that merit consideration.

Table 1

Description of Parent-Directed Teen Driving Interventions.

Interventions and Citations	License Stage		Approach	Outcomes Assessed ^a		Intervention ^b
	When Intervention Began	Targeted for Impact		Parent	Teen	
Interventions with Passive Dissemination of Media						
Checkpoints						
Hartos et al., Am J Prev Med, 2001	Intermediate	Intermediate	Print materials	2	-	1,2
Simons-Morton et al., Inj Prev, 2002	Learner	Intermediate	Video and print materials	1,2	1,2	1,2
Simons-Morton et al., Inj Prev, 2003	Intermediate	Intermediate	Video and print materials	1,2	1,2	2
Simons-Morton et al., Prev Sci, 2004	Intermediate	Intermediate	Video and print materials	1,2	1,2	1,2
Simons-Morton et al., Am J Pub Health, 2005	Learner	Intermediate	Video and print materials	1,2	1,2	1,2
Simons-Morton et al., Accid Anal Prev, 2006	Learner	Intermediate	Video and print materials	2	2	-
Simons-Morton et al., J Adolesc Res, 2006	Learner	Intermediate	Video and print materials	1,2	1,2	2
Simons-Morton et al., J Safety Res, 2006	Learner	Intermediate	Video and print materials	2	2	-
Simons-Morton et al., Traffic Inj Prev, 2006	Learner	Intermediate	Video and print materials	2	2	-
Tennessee Novice Driver Safety Project						
Chaudhary et al., Traffic Inj Prev, 2004	Learner	Learner	Print materials	2	2	1
Parental Supervision of Teenage Drivers in GDL						
Goodwin et al., Traffic Inj Prev, 2006	Learner	Learner	Print materials	1,2	1,2	1,2
Court-directed Parent Involvement Program						
Mattox, The University of Memphis, 2000	No specific phase	No specific phase	Multimedia	-	2	1,2
Parent-Teen Driving Agreement						
Lichenstein et al., Chronicle for Driver Education Professionals, 2012	No specific phase	Intermediate	Video and print materials	1,2	1,2	2
Interventions With Dissemination of Media and Direct Parent Engagement						
Adapted Checkpoints						
Zakrajsek et al., Fam Community Health, 2009	Learner	Intermediate	Multimedia and in-person	1,2	2	1,2
Zakrajsek et al., J Adolesc Health, 2013	Learner	Intermediate	Multimedia and in-person	2	2	-
TeenDrivingPlan						
Mirman et al., Transport Res Rec, 2012	Learner	Learner	Web-based and phone contact	-	-	1,2

Interventions and Citations	License Stage			Approach	Outcomes Assessed ^a		Intervention ^b
	When Intervention Began	Targeted for Impact			Parent	Teen	
Mirman et al., JAMA Pediatr, 2014	Learner	Learner		Web-based and phone contact	2	2	2
Mirman et al., J Adolesc Health, 2014	Learner	Learner		Web-based and phone contact	1,2	1,2	-
Winston et al., Inj Prev, 2014	Learner	Learner		Web-based and phone contact	-	-	1,2
Steering Teens Safe							
Ramirez et al., Health Educ Behav, 2013	Learner	Learner		Multimedia and in-person session	1,2	-	1
Peek-Asa et al., BMC Pub Health, 2014	Learner	Learner		Multimedia and in-person session	-	1,2	-
Green Light for Life							
Taubman-Ben-Ari et al., Accid Anal Prev, 2011	Accompanied	Accompanied		Multimedia and in-person	-	1,2	1
Toledo et al., Accid Anal Prev, 2012	Accompanied	Accompanied		Multimedia and in-person	-	2	-
Supporting a Teen's Effective Entry to the Roadway (STEER)							
Fabiano et al., Cogn Behav Pract, 2011	Licensed	Licensed		Multimedia and in-person	2	2	1
Safe Drivers Wanted							
Haggerty et al., Prev Sci, 2006	Learner	Learner and Intermediate		Multimedia and in-person	2	1,2	-
Interventions that Utilize In-Vehicle Data Recorders (IVDRs)							
IVDR							
Farmer et al., J Safety Res, 2010	Intermediate	Intermediate		In-vehicle feedback	-	2	1,2
McCart et al., Traffic Inj Prev, 2010	Intermediate	Intermediate		In-vehicle feedback	1,2	1,2	1,2
DriveCam							
McGehee et al., J Safety Res, 2007	Licensed	Licensed		In-vehicle feedback	-	2	-
Camey et al., Am J Public Health, 2010	Intermediate	Intermediate		In-vehicle feedback	-	2	1,2
DriveCam for Families Program							
Simons-Morton et al., J Adolesc Health, 2013	Intermediate	Intermediate		In-vehicle feedback	1,2	2	2
GreenRoad							
Farah et al., Accid Anal Prev, 2013	Accompanied	Accompanied and Solo		In-vehicle feedback and in-person session	2	2	2

^a *Parent outcomes:* 1=attitudes, perceptions, and knowledge, 2=parent behaviors (e.g., communication, supervision, limit setting, parent-teen agreement). *Teen outcomes:* 1=attitudes, perceptions, and knowledge, 2=teen behaviors (general driving behaviors, risky driving behaviors, licensure, parent-teen agreement).

Intervention use and acceptability: 1=acceptability/usefulness of intervention, 2=use of intervention materials.
b

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Table 2
Essential Characteristics of Effective Parent-involved Teen Driving Interventions and their Evaluation Studies

General Characteristics of Effective Interventions

Theory based. Intervention is conceptualized within an underlying theory, include a well-articulated logic model that explains the rationale and evidence. Intervention targets are related to key behaviors, feasible to change via intervention, and have room to change.

Parental engagement. Intervention includes direct parent involvement.

General Characteristics of Effective Evaluation Studies

Formative research. Assessment of the usability, acceptability, and implementation fidelity of the intervention is completed during the design process and before implementation.

Process and outcome level evaluations. Interventions are evaluated for process (to examine development and implementation) and outcomes (changes that occur as a result of the intervention).

Participants randomized. Study conditions are randomly assigned to participants.

Objective collection of data. The use of objectively collected data (e.g., in-vehicle, crash and violation data) should be prioritized, when appropriate and feasible.

Specific reporting of results. Effect sizes and confidence intervals should be reported in results to allow for comparison across interventions. If appropriate, measures of effect (e.g., risk ratio) should be reported instead of measures of association (odds ratio).

Trials should be registered. All randomized controlled trials should be registered with the aim of avoiding selective reporting of results