The effectiveness of alternative transportation programs in reducing impaired driving: A literature review and synthesis

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A B S T R A C T

Introduction: Studies have shown that approximately half of arrested intoxicated drivers had their last alcoholic drink at a licensed bar or restaurant. Current efforts to prevent intoxicated patrons from leaving licensed establishments and driving home have been only partially successful. Since a high proportion of drinkers drive to their drinking destination, promoting the use of alternative transportation (AT) – including safe ride shuttles, free or subsidized taxi and ridesharing services, voluntary or paid designated driver programs, and more accessible public transportation – is an important strategy for preventing impaired driving. The primary goal of this study was to review and synthesize the findings of research studies designed to test the effectiveness of AT programs in reducing alcohol-impaired driving. A secondary goal was to report if using AT has led to any unintended consequences, in particular greater alcohol consumption. *Method:* We identified relevant academic articles, new articles, government reports, and other documents (English only) through the University of Chicago library, Google Scholar, and Google Search. We also included published articles recommended by peers. Key search terms included: alternative transportation; safe rides; designated driver; alcohol-impaired driving; alcohol consumption, cost effectiveness; and reduce drunk driving. Initially, we identified 168 potentially relevant sources, of which only 57 were academic articles. After a thorough review, we narrowed down the number of relevant articles to 125 including some background articles and government reports. *Results:* Some AT programs produced reductions in one or more of the following outcomes: (1) impaired driving; (2) impaired driving crashes; (3) driving under the influence (DUI) arrests; and (4) traffic crashes in general, but others were not shown to be effective. A few programs resulted in greater self-reported alcohol use, but there were no significant findings indicating that drinking when using AT led to an increase in alcohol-related harms such as public intoxication, assaults, or other alcohol-related crime. Of the studies that conducted a cost-benefit analysis, most showed that AT programs yielded a positive benefit, but these studies did not include a sufficient number of variables to be considered true cost-benefit analyses. *Conclusions:* There is mixed evidence regarding the effectiveness of AT programs. Evaluations with more rigorous quasi-experimental and experimental designs are needed to identify which types of AT programs work best for different types of communities and target groups. *Practical Applications:* The literature review and synthesis revealed that the most successful AT programs typically have some of these attributes: (1) social acceptance; (2) high level of public awareness; (3) low cost; (4) year-round availability; (5) provide rides to and from drinking venues; (6) several sponsors that provide funding); (7) user convenience; and (8) perceived safety.

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1. Introduction

Of the 37,473 people killed in traffic crashes in 2018, over one quarter (10,511) were in an alcohol-related crash (NCSA, 2019).

Significant progress has been made since the 1980s (Dang, 2008), but impaired driving crashes still account for over 10,000 deaths each year. Moreover, each year impaired driving results in approximately 350,000 people being injured, plus more than 3.5 million crashes causing property damage totaling an estimated $125 billion (Zaloshnja, Miller, & Blincoe, 2013). Over the past 20 years, roughly 1.4 million drivers have been arrested annually for driving under the influence of alcohol (DUI), though this number has

decreased in recent years to less than 1.0 million DUI arrests per year (Bureau, 2019; Fell, 2019a).

Between 1982 and 1997, effective DUI laws were adopted by most of the 50 states and the District of Columbia (Fell & Voas, 2006). As a result, the proportion of traffic fatalities involving an alcohol-impaired driver decreased during that time period and in subsequent years. One reason for this change was that alcohol consumption per capita decreased. However, while the drop in fatal crashes involving an alcohol-impaired pedestrian almost mirrored the decrease in alcohol consumption, the reduction in fatal crashes involving an alcohol-impaired driver was greater (NHTSA, 2009; Lakins, LaVallee, Williams, & Yi, 2008). As an illustration of this, see Fig. 1. Another important reason was the rise in the social acceptance and use of designated drivers in the 1980s and early 1990s. These data suggest that drivers changed their behavior through some combination of drinking less alcohol, drinking more often at home rather than driving to an on-premise outlet, and using alternative transportation to get home after drinking at a bar or restaurant.

Traffic crashes are a global problem that result in approximately 1.35 million fatalities each year (WHO, 2018). Consider, for example, the member countries of the Economic and Social Commission for Asia and the Pacific (Fell, 2019c). Drink-driving is the major cause of road traffic fatalities the Marshall Islands, Palau, Papua New Guinea, Australia and Tonga, while accounting for approximately one third of total road traffic deaths in Vietnam, one-fourth in Thailand and Malaysia, and more than 20% in Mongolia and Azerbaijan. A recent study indicated that in the Russian Federation, which has a particularly high level of alcohol consumption, 38.3% of male traffic fatalities and 25.2% of female traffic fatalities can be attributed to alcohol (Razvodovsky, 2016).

The growing number of traffic fatalities worldwide has made the need to improve highway safety a global priority. In 2010, the United Nations proclaimed 2011–2020 as the "Decade of Action for Road Safety" and included two Sustainable Development Goals focused on road safety in its 2030 Development Agenda. Target 3.6 called for halving global deaths and injuries from road traffic crashes by 2020, while target 11.2 called for providing access to safe, affordable, accessible, and sustainable public transport systems (European Commission, 2010; United Nations, 2015; WHO, 2017).

Despite new DUI laws, targeted law enforcement, and public communication campaigns (Fell, 2019b), studies from the United States have generally shown that about half of intoxicated drivers, arrested or on the roads, had their last drink at a licensed bar or restaurant (Anglin, Caverson, Fennel, Giesbrecht, & Mann, 1997; Eby, 1995; Foss, Perrine, Meyers, Musty, & Voas, 1990; Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, Brainard, & Berning, 2009). An analysis of large national surveys conducted in 2007 and 2008 revealed that 54.3% of the respondents classified as "binge drinkers" (5 + drinks on a single occasion in the past 30 days) who drove during or within two hours of their most recent binge drinking episode had consumed most of their alcohol at a bar, club, or restaurant. On average, these individuals consumed an average of 8.1 standard drinks, with 53.1% consuming 7 + drinks and 25.7% consuming 10 + drinks (Naimi, Nelson, & Brewer, 2009). Since a high proportion of drinkers drive to their drinking destination, alternative transportation becomes an important factor in reducing impaired driving.

One popular option that has garnered attention both in the United States and worldwide is choosing a designated driver. Using a designated driver to reduce impaired driving has been practiced in Scandinavia (where it originated) and other parts of Europe since the 1920s (Lange, Voas, & O'Rourke, 1998; NASEM, 2018). This strategy gained popularity in the United States after being promoted through prime-time television programming and network-sponsored public service announcements in the late 1980s and early 1990s (Winsten & DeJong, 2000).

Many drivers report being a designated driver in the past year, but it remains unclear whether this practice has resulted in less frequent impaired driving (Ditter et al., 2005). Yet a 1993 survey of more than 17,000 U.S. college students does suggest that the designated driver campaign may have had this effect (DeJong & Winsten, 1999). Among drinkers, 1,908 students who could be classified as heavy drinkers (5 + drinks for males at least once in the past 2 weeks, 4 + drinks for females) reported not drinking heavily the last time they served as a designated driver. At the same time, just 1,031 students who normally did not drink heavily did so the last time they rode with a designated driver.
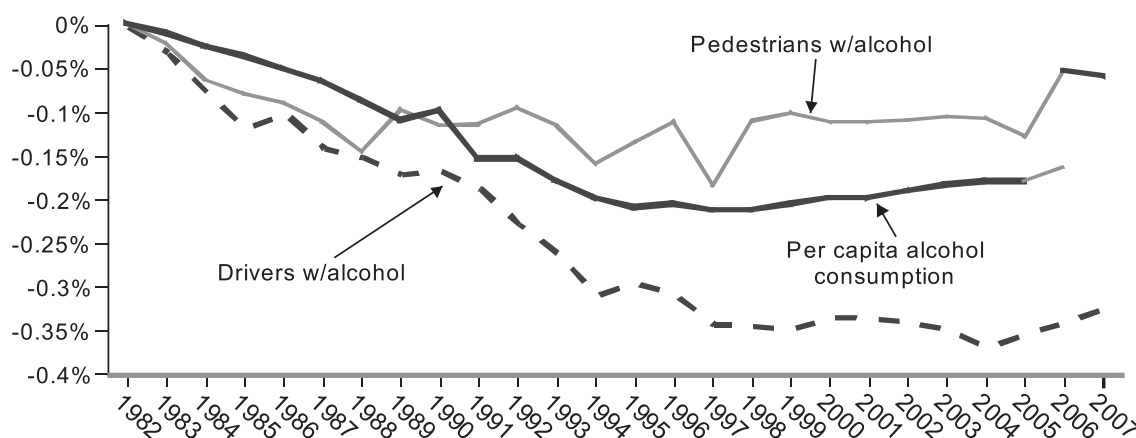
Source: NHTSA, 2009; Lakins, LaVallee, Williams et al., 2008

* Drinking drivers and pedestrians include anyone with a measured BAC ≥ 0.01 g/dL.

Fig. 1. Percentage reductions in fatally injured drinking drivers and pedestrians and per capita alcohol consumption in the United States, 1982 to 2006* Source: NHTSA, 2009; Lakins, LaVallee, Williams et al., 2008 * Drinking drivers and pedestrians include anyone with a measured BAC ≥ 0.01 g/dL.

In the 2007 National Roadside Survey (NRS), drivers were asked if they were the designated driver. Out of 6,791 drivers tested for BAC on weekend nights, 1,892 (28%) said they were the designated driver. Breath tests indicated that 2.5% of these designated drivers had a BAC greater than 0.08 g/dL and another 13.5% had a BAC of 0.01 –0.07 g/dL (Lacey et al., 2009). The vast majority of designated drivers abstain, as they should, but not all do. These findings underscore the point that alternative transportation (AT) programs are needed, including safe ride shuttles, free or subsidized taxi and ridesharing services, voluntary or paid designated driver programs, and more accessible public transportation (Boots & Midford, 1999; Humphreys, Degli Esposti, Williams, Kondo, & Morrison, 2020; Molof, Dresser, Ungerleider, Kimball, & Schaefer, 1995). Additionally, a recent study by MacLeod et al. (2020) concluded that improving the speed of service, convenience, and safety appear to be important factors in the use of alternatives to drinking and driving. This has implications for optimizing ride-sharing services for specific people who drink and drive. With the advent of ride-sharing services being implemented in many communities in recent years, it became clear that a review of the literature on the effectiveness of AT programs in reducing impaired driving was needed.

Therefore, the primary goal of this study was to review and synthesize the findings of research studies designed to test the effectiveness of AT programs in reducing alcohol-impaired driving. A secondary goal was to report if using AT has led to any unintended consequences, in particular greater alcohol consumption and/or intoxication.

2. Methods

2.1. Identifying documents for review

We conducted online searches in Google Scholar, Google.com, and bibliographic and full-text electronic databases accessed through the University of Chicago library, including Articles Plus, Cochrane Library, Medline, ISI Web of Science, ProQuest, PsycINFO, PubMed, Science Citation Index, Social Sciences Citation Index, Social Services Abstracts, Scopus, and WorldCat. We employed several search terms and combinations of terms; those yielding the greatest number of documents are listed in Table 1. In total, we identified 165 potentially relevant academic articles, reports, news articles, websites, and other unpublished documents (gray literature). Although we included literature published internationally, we only reviewed articles that were written in English.

Table 1
Search terms yielding the greatest number of documents for review.

Search Terms	Initial Search Results	Relevant Literature
alternative transportation	8	7
alternative transportation + alcohol impaired driving	7	6
alternative transportation + crime	3	3
alternative transportation + DUI	3	3
cash back programs + safe rides	1	0
designated driver	19	17
safe ride program	9	8
safe ride program + cost	1	1
safe rides + cost effectiveness	8	1
safe rides + effectiveness	10	10
safe rides + reduce drunk driving	19	17
sponsors + safe ride programs	2	2

We reviewed the abstracts and results sections of academic articles, book chapters, dissertations, and other lengthy documents, and read news articles, website pages, and other short documents to identify those that both discussed drink driving and described an AT program. This narrowed down the total number of relevant materials to 125. The top four categories were academic journals (57), reports (25), news articles (17), and websites (6); an additional 15 categories accounted for 1–3 documents each.

3. Results

We first reviewed four aspects of the AT programs described in literature: (1) community context, (2) modes of transportation, (3) user profiles, and (4) marketing and advertising. In turn, we summarize the evidence of effectiveness for AT programs.

3.1. Community context

The literature suggests that AT programs are more likely to gain community support and be successful if they are developed in consultation with key constituencies, including bar, club, and restaurant owners and managers; local, regional, or state business associations; local law enforcement, public health, and government officials; community leaders from institutions of higher education, and neighborhood associations, and other local organizations; and potential AT users (Dills & Mulholland, 2018; Tavern League of Wisconsin SafeRide Program, 2019).

Wisconsin's *Road Crew* program operates in rural communities and small towns that lack public transportation systems to provide rides to, between, and home from on-premise alcohol establishments (Road Crew Reduces Drunk Driving, n.d; Rothschild, Mastin, & Miller, 2006). The program was designed with input from local bar owners and managers, representatives of the primary target group (young men, 18–24), community leaders, and officials from a major brewer and the Tavern League of Wisconsin. A study in three *Road Crew* communities showed that two of the programs reduced alcohol-impaired driving and became self-sustaining through tavern contributions and fares. The third did not succeed, which the researchers attributed to a lack of trust among the coalition members and other members of the community (Rothschild et al., 2006).

The *Last Call* program in Portland, Oregon, and Seattle, Washington, faced opposition from some bar owners who thought the program would not benefit them financially and did not want to pay for taxi vouchers to give customers a price discount. Program managers also initially faced difficulty placing taxi stands closer to the participating bars when some owners near the selected locations expressed concern about potential impacts on their business (Rivara, Boisvert, Relyea-Chew, & Gomez, 2012). In contrast, a Minnesota program also called *Last Call* was operated by a group of bar owners and received financial support from a major brewer and a local beer distributor to pay for ride vouchers (Sprattler, 2010). Planning for the program began with a community needs assessment to assess which AT approach would be appropriate and well-received by both the business community and their customers.

3.2. Modes of transportation

The research literature focuses on a variety of AT programs: safe ride shuttles; free or subsidized taxi, ridesharing, and public transportation; and voluntary or paid designated driver programs (Molof et al., 1995; Boots & Midford, 1999; Caudill, Harding, &

Moore, 2000; Harding, Caudill, Moore, & Frissell, 2001; Sarkar, Andreas, & de Faria, 2005; Elam, McKaig, Jacobs, Whitlow, & Gros Louis, 2006; Rothschild et al., 2006; Decina, Foss, Tucker, Goodwin, & Sohn, 2009; Meece, 2009; Nielson & Watson, 2009; Caudill, Rogers, Howard, Frissell, & Harding, 2010; Gieck & Slagle, 2010; Sprattler, 2010; Chan, 2011; Rivara et al., 2012; Weber, 2014; Tiegs, 2015; New Jersey Opinion, 2016; National Academy of Sciences, 2018; Jarchow, 2018; Tavern League of Wisconsin SafeRide Program, 2019.). These programs vary by the types of services provided and marketing and incentive strategies.

Many AT programs provide one-way transportation from a drinking establishment to a final destination, typically the patron's residence. A common approach is to give vouchers to bar patrons to provide a free or low-cost ride home using a taxi service (Simons-Morton & Cummings, 1997; Caudill, Harding, & Moore, 2001; Harding et al., 2001; Decina et al., 2009; Sprattler, 2010; Rivara et al., 2012). More recently, partnerships have been formed with rideshare services such as Uber and Lyft (Fortin, 2017; King, 2019; Meece, 2009; Ray, 2018). Sacramento State University's reimbursement program gives students who used Uber or Lyft a voucher worth up to $20 for a future ride after submitting their receipt to the student council (Ray, 2018). In effect, these AT programs serve as a backup strategy for getting home when customers become impaired. A drawback, of course, is that they then face the inconvenience of coming back to retrieve their car the next day.

AT programs have tried different ways to eliminate that problem. A program in Frederick, Maryland, provided taxis to take patrons home, but also free return service the next day so they could pick up their car. The program coordinated with both city officials and bar owners so that patrons could leave their cars overnight without being fined or towed if they used the taxi service (Caudill et al., 2000; Harding et al., 2001). Some potential users worried their car might be vandalized when left overnight (Caudill et al., 2000). In Florida, *Tow to Go* partnered with a towing company to transport the driver and their car home. Potential users who declined the service expressed concern that the tow truck would make too much noise or damage their vehicle (Decina et al., 2009).

Operation Red Nose (Operation Nez Rouge) in Canada, uses volunteer designated drivers to get drinkers home during the December holiday season (Lavoie, Godin, & Valois, 1999; Nose, 2020). Clients who drove alone or with friends in their own car can request a ride by calling or using the service's mobile app. A volunteer "escort driver" drives two other volunteers to the client's location. One volunteer is the "designated driver" and drives the client and any passengers to their homes using the client's own car. As the "navigator," the other volunteer rides along to talk with the passengers so the driver will not be distracted. The escort driver follows behind and picks up the designated driver and navigator once they have brought the client home. In 2019, the program's 36th year, volunteers drove home 69,029 Canadians who reached out for a safe ride (Nose, 2020). Similar programs have a volunteer designated driver travel by electric scooter to pick up the client and then drive the client's car with the scooter stored in the trunk (Decina et al., 2009). Some volunteer designated driver programs match the client with a driver of the same gender (Decina et al., 2009; Meece, 2009). One barrier faced by this type of program is that some patrons feel uncomfortable when someone else drove their car (Apsler, 1988; Chan, 2011; Huseth, 2012; Rothschild et al., 2006; Sarkar et al., 2005; Sprattler, 2010).

Other AT programs offer services to, from, and between locations, which maximizes convenience but may be more costly to implement and may encourage some patrons to plan in advance to binge drink. One example, described above, is Wisconsin's *Road Crew* program, which provided subsidized rides covered by tavern contributions and fares (Road Crew Reduces Drunk Driving, n.d;

Rothschild et al., 2006). Additionally, one program in two New Jersey counties, the *Evesham Saving Lives* program, used funds collected from philanthropic organizations to cover Uber rides within those counties. Riders were able to obtain a subsidized trip of up to $30 between their home and bars in those counties between 9 p.m. and 2 a.m. (Humphreys et al., 2020). Likewise, some colleges and universities provide safe ride shuttles to and from pre-defined pick-up and drop-off areas, while others use taxicabs or a student-run designated driver service so that students have greater scheduling flexibility (Chan, 2011; Elam et al., 2006; Gieck & Slagle, 2010; Logan, 2014; Mohlfeld, 2017; Zimmerman & DeJong, 2003). Some of these programs are free or covered through student fees, while others are offered a price discount.

Some cities and towns worked with their public transportation system to lower fares, such as the *Jolly Trolley* in Rehoboth, Delaware (Decina et al., 2009). In other cases, service hours were extended; Melbourne, Australia, for example, extended service to 24 hours a day (Curtis et al., 2019). Adding service locations helps, too. By extending the light rail system for the Phoenix area into Arizona State University's campus, students were provided a safer alternative for traveling to and from downtown (Broyles, 2014).

3.3. User profiles

The evaluation studies we reviewed often noted that heavy drinkers, a group also at greater risk for driving after drinking, were the most likely to use an AT program (Boots & Midford, 1999; Caudill et al., 2000, 2001, 2010; Dornier, Fauquier, Field, & Budden, 2010; Elam et al., 2006; Gieck & Slagle, 2010; Harding et al., 2001; Logan, 2014; McNamee, 2020; Mundorf, 2006; Sarkar et al., 2005; Vickery, 2014). In fact, study participants typically state that when they do use a designated driver or an AT program, their primary motivation is to avoid being stopped by police for DUI (Caudill et al., 2001, 2010; Chan, 2011; Gieck & Slagle, 2010; Griswold, 2014; Huseth, 2012; Rayle, Dai, Chan, Cervero, & Shaheen, 2016; Sarkar et al., 2005).

It is important to note that college students are more likely than their non-college peers to drink heavily (DeJong & Winsten, 1999; Dornier et al., 2010; Elam et al., 2006; Gieck & Slagle, 2010; King, 2019; Mohlfeld, 2017; Rivara et al., 2007, 2012; Rothschild et al., 2006; Wicklund, Hing, Vanlaar, & Robertson, 2018). Therefore, it is not surprising that a number of the AT programs that have been evaluated targeted a college or university population; students typically indicate support for these programs (Chan, 2011; Dornier et al., 2010; Elam et al., 2006; Gieck & Slagle, 2010; Logan, 2014; McNamee, 2020; Mohlfeld, 2017; Staley, 2018).

In these studies, by far the largest percentage of AT users were White males ages 18–35 (Caudill et al., 2010; Elam et al., 2006). There are several possible reasons why non-White patrons appear to underutilize these programs. Among persons ages 18 and older, non-Whites are less likely to be heavy drinkers (SAMHSA, 2014; Delker, Brown, & Hasin, 2016) or to drive after drinking (Chartier & Caetano, 2010). An additional possibility that should be investigated is that AT programs may be developed less often in urban minority neighborhoods or for establishments that serve a largely non-White clientele.

3.4. Marketing and advertising

A few programs have used social marketing techniques when designing and promoting their AT service. Wisconsin's *Road Crew* program conducted focus groups with members of their intended target group, young men, to learn what program features and advertising messages would draw their attention to the program (Road Crew Reduces Drunk Driving, n.d; Rothschild et al., 2006). That effort paid off. The program succeeded in reducing alcohol-

impaired driving and has become, according to one article, part of the community's culture (Road Crew Reduces Drunk Driving, n.d.).

Minnesota's *Last Call* program was first pilot tested during winter holidays so that it could be revised before its full-scale launch. Participating bars and restaurants gave patrons vouchers for a discounted ride, plus a free ride the next day to retrieve their car. The program was promoted in the participating establishments, but also on television. One report stated that *Last Call* had become popular in the community, but did not indicate whether it proved to be effective in reducing impaired driving (Sprattler, 2010).

A program in Australia, *Pick-a-Skipper*, was implemented to promote the use of designated drivers. In Geraldton, a coastal city in Western Australia, a television advertising campaign encouraged people to select a "skipper" before arriving at a bar. One nightclub also offered skippers free soft drinks to encourage them to stick with their plan not to drink, a strategy frequently used in the United States. An evaluation revealed that staff at the door did not consistently announce the program, and few patrons identified themselves as the skipper upon entering (Boots & Midford, 1999). Although advertising campaigns can increase awareness of an AT program, unless patrons feel the need to use them, due to social pressure or DUI enforcement, they are unlikely to succeed.

3.5. Program effectiveness

The literature review also provided an opportunity to review the programs in more detail to determine whether they were successful in accomplishing their goals. This section described how effective AT programs are with respect to key outcomes such as: reduction in impaired driving; reduction in impaired driving related crashes; reduction in crime; and effect on drinking behaviors. We also attempted to review articles that covered cost-benefit analysis of AT programs.

Additionally, we closely analyzed select AT programs to better understand the effects of the programs. Table 2 provides descriptive details about select AT programs and the evaluation data. Because these communities typically use several strategies to reduce alcohol-impaired driving (e.g., increased police sobriety checkpoints, adopting and publicizing laws with harsher penalties), it can often be difficult to conclude that an AT program alone was the key to a reported reduction in DUI (Decina et al., 2009; Goodwin et al., 2015). Even so, research does show that some well-implemented programs can reduce the number of impaired drivers on the road, high-risk drinking behaviors, and even non-DUI crimes. Our findings are presented more fully below.

3.6. Reduction in drink driving

Many of the articles reported that the AT program reduced impaired driving because a certain number of potential drivers with blood alcohol concentrations (BACs) over the legal limit were not on the road (Caudill et al., 2000), or because a program or service was available (Rayle et al., 2016). Some reported fewer DUI arrests (Downie & Abaluck, 2018; MADD, 2015; Martin-Buck, 2016) associated with the AT program. In a report about Uber's entrance into Seattle, MADD was able to make a statistically significant association between Uber and a 10% reduction in DUI arrests (MADD, 2015). However, other factors could have influenced this finding such as other drunk-driving prevention strategies (e.g., more police presence or stricter laws) or access to other transportation methods (e.g., subway systems) (Decina et al., 2009; Downie & Abaluck, 2018; Lacey, Jones, & Anderson, 2000; Peck, 2017; Sykes, Hopkin, & Groom, 2014).

One article indicated that Uber's entry in New York City had a positive effect on reducing drunk driving. However, given the city's access to a number of transportation options (e.g., subway system,

taxi-cabs), it was difficult to attribute that reduction solely to Uber's presence (Peck, 2017). Another author indicated that there was a small reduction in DUIs when Uber was introduced in 15 Illinois counties. However, it was noted that the DUI reduction with respect to Uber may be misleading, as those who use Uber are likely individuals with larger incomes, and that the "population of DUI offenders may not be independently distributed across demographics" (Downie & Abaluck, 2018).

Researchers found that the voucher program for *Road Crew* had a statistically significant effect on reducing alcohol impaired driving over time, in particular with the target population of young adults (ages 21–34 years old) (Rothschild et al., 2006). Other articles also reported that the availability of a safe ride program, including designated drivers, suggested a potential shift away from drinking and driving (Decina et al., 2009; Sprattler, 2010; Wicklund et al., 2018). While these results were promising, self-reported data on behaviors may not be as reliable as hard data (e.g., DUI arrests; DUI crashes). Additionally, a number of articles still report that there was not enough evidence or data suggesting that programs are effective at reducing drinking and driving (Nielson & Watson, 2009; Sykes et al., 2014; Goodwin et al., 2015; National Academy of Sciences, 2018), and one article indicated that it may be difficult to measure effectiveness given that program operations vary across communities (Huseth, 2012).

With respect to designated drivers, many of the articles that focus on designated driving indicated that drivers still consumed alcohol (Bergen, Yao, Shults, Romano, & Lacey, 2014; DeJong & Wallack, 1992; DeJong & Winsten, 1999; Fell, Voas, & Lange, 1997; Glascoff & Knight, 1994; Glascoff, Wallen, & Shrader, 2012; Knight, Glascoff, & Rikard, 1993; Logan, 2014; Shore, Gregory, & Tatlock, 1991; Timmerman, Geller, Glindemann, & Fournier, 2003). Participants in one study indicated that while they understood that designated drivers are intended to be more responsible when driving passengers home, it was not always perceived that they had to fully abstain from alcohol (Glascoff & Knight, 1994). While much of the designated driver literature showed evidence that designated drivers do drink, other studies reported that designated drivers abstained from drinking because they were incentivized (Lange et al., 2000, 2006; Meier, Brigham, & Gilbert, 1998) or generally did not drink as much as those requesting to be driven (Sykes et al., 2014). Successful marketing campaigns encouraged drinkers to identify a designated driver prior to arriving at a bar (Lange, Reed, Johnson, & Voas, 2006; Boots & Midford, 1999) and more formalized programs, such as *Project Red Nose*, offered opportunities for patrons to benefit from a volunteer designated driver that could take them home in their own vehicle (Lavoie et al., 1999).

3.7. Reduction in drink driving related crashes

The ultimate goal of AT programs is to reduce the injuries and fatalities associated with impaired driving crashes. The results on this measure were mixed, ranging from very small and statistically insignificant, to no perceived differences, and a few instances of large statistically significant decreases (Harding, Apsler, & Goldfein, 1988; Lacey et al., 2000; Rothschild et al., 2006; Nielson & Watson, 2009; Sprattler, 2010; Huseth, 2012; Sykes et al., 2014; Goodwin et al., 2015; Brazil & Kirk, 2016; Morrison, Jacoby, Dong, Delgado, & Wiebe, 2017; Richard, Magee, Bacon-Abdelmoteleb, & Brown, 2018). The evaluation of the *Tipsy Taxi* program in Aspen, Colorado reported a reduction of 4% in nighttime crashes after the program was implemented, but it was not statistically significant. However, the same study did show a statistically significant reduction in injury crashes of 15% (Lacey et al., 2000). Two other studies also reported small decreases in fatal crashes in communities after Uber was introduced (Dills &

Table 2
Summary of findings from select evaluation studies.

Authors/Year	Jurisdiction	Program/ Service Studied	Characteristics of Population Studied	Findings	Measures Used	Comparison Group Used
Brazil & Kirk, 2016	100 most populated metropolitan areas in the United States	Uber	General population of those who drink and drive	Uber's entrance in a given county was not associated with the number of traffic fatalities	Drunk-driving fatalities	None
Caudill et al., 2001	2 Maryland communities	Designated drivers (DD)	Male and female drinkers, 21 and older	DDs more likely to engage in risky drinking behaviors compared to those who do not typically serve as DDs. Those who served as DDs were also more likely to use safe ride programs	BAC; alcohol use; drunk-driving behaviors	Non-designated drivers (self-reported)
Decina et al, 2009	5 programs (4 in the US and 1 in Canada)[**]	• I'm Smart • SoberCab • Tipsy Taxi • CareFare • Road Crew • Operation Red Nose	Male and females, ages 18 and older	Depending on the program, the findings varied: • I'm Smart and SoberCab: High level of awareness, but low ridership • Tipsy Taxi: Used frequently, with small effect on reducing crashes. • CareFare: Limited use, limited promotion of program • Road Crew: Reduced number of crashes, and high level of awareness • Operation Red Nose: High level of awareness	Program awareness; alcohol-related crashes; injury crashes; nighttime crashes; fatal crashes; ridership	Comparison counties and communities were studied in the evaluations of I'm Smart, SoberCab, Tipsy Taxi, and Road Crew
Elam et al., 2006	1 university	Midnight Special Late Night Bus Service at Midwestern University	College students	Data were collected from college leaders, college students, bus monitors, and police. Students aware of the program, but not be used frequently given capacity and availability. Respondents find that it helps keep drinking students off the road, but its effect on reducing OUIs is inconclusive; some respondents think the program encourages more drinking.	Program awareness; program perceptions; ridership; OUI	None
Harding et al., 2001	1 community in Maryland	Safe Ride program in Frederick, MD	Frederick, MD residents 21 and over	72% of respondents BAC levels stayed the same (either in the low risk (BAC less than 0.10 g/dL) or high risk range (BAC greater than or equal to 0.1)) when using a safe ride program. 24% of respondents increased from low risk to high risk when using a safe ride program.	BAC; alcohol use; drunk-driving behaviors; frequency of using DDs or safe ride programs	None
Lacey et al, 2000	3 counties in Colorado (1 treatment county – Pitkin – and 2 comparison counties – Gunnison and San Miguel)	Tipsy Taxi	General population of those who drink and drive	Reduced injury crashes by 15%; committed staff and community support allows for program success	Nighttime crashes; injury crashes; ridership	2 comparison counties
Lange et al., 2006	1 pedestrian border crossing between San Diego and Tijuana, Mexico	Designated drivers (DD) selected by their group and assigned to one of seven possible cueing interventions	San Diego county residents between the ages of 18 and 30 crossing into Tijuana	DDs, regardless of intervention assigned, had lower BACs than their passengersWhile many DDs still drank, those who were part of the group norm intervention (randomly selected person in the group read a pro-DD statement) had the lowest BACs compared to DDs in the other interventions. Similarly, passengers in this group also had lower BACs compared to passengers in the other interventions.	BAC (pre-post); DD perceptions; DD expectations	Study groups were compared to each other and assigned to one of seven possible interventions: • Control group (no DD selected) • Cue only (DD selected) • Cue plus reminder (DD selected, DD wears bracelet) • Attitude change (DD selected, DD reads pro-DD statement to self and group, $1 fast-food incentive, asked if DD before) • Driver reward (DD selected, DD $10 reward if return sober)

Table 2 (continued)

Authors/Year	Jurisdiction	Program/ Service Studied	Characteristics of Population Studied	Findings	Measures Used	Comparison Group Used
						• Group reward (DD selected, everyone in groups receives $10 reward if DD returns sober) • Group norm (DD selected, $1 incentive, randomly selected passenger reads pro-DD statement)

* The report indicates that many alternative transportation programs operate within the state of Minnesota, but focused specifically on 4 program case studies.

** The report describes several programs at a high level to show that alternative transportation programs can be implemented in different ways. The report reports evaluation for 5 programs in depth detail and are summarized here.

Mulholland, 2018) and between a 3.6% and 5.6% reduction per quarter in California (Greenwood & Wattal, 2017). However, the reduction in crashes may be significant in one community compared to another depending on community characteristics. As noted in the *Tipsy Taxi* Evaluation (Lacey et al., 2000), the program operated in a community that has relatively few crashes and thus the reductions were minimal. Additionally, cities with robust public transportation may not have generalizable findings that could translate to other communities as other options were available outside of a safe ride program (Peck, 2017).

One recent study looked at the effects of the entrance of ride sharing services (to include Uber and Lyft) on the reduction of alcohol-related crashes. Through a retrospective analysis of Level 1 trauma data as well as law enforcement and government traffic databases, the authors found that there were statistically significant decreases in the annual average proportion of alcohol-related crashes pre- to post-entry of ridesharing services (39% before, and 29% after), as well as statistically significant decreases in the annual average of fatal alcohol-related crashes (11.6 before, and 5 after) (Friedman et al., 2020).

3.8. Reduction in crime

The "*Be On the Safe Side (BOSS)*" safe ride program available to University of Wisconsin students, a university located in a large metropolitan setting, allowed for students to make contact with the service and a van would then pick up the students and take them to their destination. The service was limited to a radius of 1.5 miles around the campus and operated primarily in the evening hours. Research determined that a 14% decrease in crime occurred (fixed effects model), using data from the Milwaukee Police Department. However, there were a number of limitations in that the service area was in a middle-class neighborhood with a low crime rate. The author posited that results may be different in areas where there is higher crime (Weber, 2014). Reductions in crime were reported for other programs, such as fewer assaults, robberies, and reports of public intoxication (introduction of Uber and Lyft, using national data (Martin-Buck, 2016); University of Horeshead shuttle program (Longwell-Grice & Siever, 2018)). In the instance of another university program in a rural setting, administrators and campus police felt less concerned about student safety because of the presence of the program (Mohlfeld, 2017).

A few articles also focused on the entrance of Uber and its effect on reducing crime. One Uber supported report indicated that assaults on drivers and patrons (e.g., robbery attempts) were reduced given that they operate on a cashless system (Uber, 2015), and another indicated that Uber had a small effect on the reduction of physical assaults (Weber, 2019). While these two articles provided positive findings with respect to Uber's effect on crime, another article found that a community was no less likely to experience crime with or without the entrance of Uber (Dills & Mulholland, 2018).

3.9. Effect on drinking behaviors

A small number of articles indicated that fewer patrons drank as a result of safe ride programs. One article described an experiment conducted at the California and Mexico border, where researchers randomly assigned different conditions (e.g., identify a designated driver, driver receives a reward if an alcohol breath test is negative) to groups of young adults (between the ages of 18 and 30) who were intending to visit bars in Tijuana. Results showed that when groups were told to designate a driver and read a statement about refraining from drinking and driving (along with a gift certificate), both the driver and the passengers were less likely to drink com-

pared to groups assigned to other conditions (Lange et al., 2006). However, other studies found that there was no change to drinking behaviors as a result of implementing a safe rides program or introducing Uber into a community (Harding et al., 2001; Elam et al., 2006; Rothschild et al., 2006; Chan, 2011; Huseth, 2012; Sykes et al., 2014; Brazil & Kirk, 2016; Burgdorf, Lennon, & Teltser, 2019).

With respect to evidence of increased drinking by AT users, some articles indicated that those who increased their alcohol consumption were already classified as heavy drinkers or people who typically engage in risky behaviors (Shore et al., 1991; Barr & MacKinnon, 1998; Caudill et al., 2000, 2001; Harding et al., 2001; Grube & Nygaard, 2009; Family Sues Over Safe Ride Program, 2014). Other studies also noted that those who use safe ride programs or designated drivers were likely to have higher BAC's generally or were more likely to have a few more drinks because they were not driving (Chan, 2011; Sykes et al., 2014; Bourdeau, Miller, Johnson, & Voas, 2015; National Academy of Sciences, 2018). None of the articles reporting an increase in the number of drinks consumed when participants used AT reported any adverse harms in this behavior (e.g., no increase in assaults or other alcohol-related crime). Long term effects of this reported increase in alcohol consumption were not measured in any study.

In addition to these studies indicating that users of safe ride programs consume more alcohol, other literature suggested that it was either difficult to make the association given limited evidence (Huseth, 2012), that there was no significant difference in drinking after introducing a safe ride program (Rothschild et al., 2006), or the data were inconclusive (Chan, 2011; Elam et al., 2006; Rivara et al., 2007; Sykes et al., 2014).

3.10. Cost benefit analysis

There were very few articles on cost-benefit analysis ($n = 10$), and those that did cover it did so on a minimal level (e.g., just a small part of the study; Rothschild et al., 2006; Gieck & Slagle, 2010; Huseth, 2012; Weber, 2014; MADD, 2015; Uber, 2015; Graf, 2017; Greenwood & Wattal, 2017; Mohlfeld, 2017.). For instance, one report described how a safe ride program at a rural university was cost-effective in that the number of campus police officers who reported overtime hours decreased during the hours in which the program was provided (Mohlfeld, 2017). Another author showed how safe ride programs were just as effective as increasing police presence in the program's service area by 1.2%; the program was also more affordable than increasing police presence. However, the author notes that this was a "very rough approximation" (Weber, 2014).

4. Conclusions and recommendations

The literature in our search confirmed some of what has been discussed in the past, that there is limited evidence around the effectiveness of alternative transportation programs. Nonetheless, some studies and articles reported that some programs can influence change in harmful outcomes, even if they are not large effects (see Table 2). For example, some Safe Rides programs had some effect on either reducing impaired driving, reducing impaired driving crashes, reducing DUI arrests, reducing crashes and/or reducing fatal crashes (e.g., *Tipsy Taxi,* Lacey et al., 2000; *Road Crew,* Rothschild et al., 2006; Uber, Morrison et al., 2018; Peck, 2017). There were also several programs that did not show any measure of effectiveness for Uber (Brazil & Kirk, 2016; Greenwood & Wattal, 2017); public transit service expansion (Curtis et al., 2019); or designated drivers (Goodwin et al., 2015; National Academy of Sciences, 2018). In other studies, it was revealed that

the use of a designated driver or Safe Ride program resulted in either minimal or no significant changes in behavior (Ditter et al., 2005; Huseth, 2012; Richard et al., 2018; Rothschild et al., 2006).

There were a sufficient number of articles that supported concerns related to other effects of these programs, such as drinkers who use alternative transportation tend to have more drinks when doing so (Harding et al., 2001; Sarkar et al., 2005). However, there was also no indication that drinking when using alternative transportation caused additional or increased alcohol-related harm (of course, long-term effects were not measured; Curtis et al., 2019). Of the studies that conducted cost-benefit analyses, most did show a positive cost to benefit ratio around AT programs (e.g., a cost of $1 for the program saved $3 in reductions in crashes or some measure of impaired driving; Gieck & Slagle, 2010). However, the small number of peer-reviewed cost benefit studies available suggest that more work is needed to support the idea that AT programs have a positive cost to benefit ratio. Additionally, these studies were not comprehensive and did not include a sufficient number of variables for them to be considered true cost-benefit analyses (e.g., studies showing that fewer over-time hours were reported by campus police, or because there was an increase in Uber ridership during times in which drunk driving is most common, therefore a likely cost savings; MADD, 2015; Uber, 2015; Mohlfeld, 2017).

5. Practical applications

5.1. AT features

We have concluded from the literature review that successful alternative transportation (AT) programs tend to have the following attributes:

- They are socially acceptable to the community (e.g., based upon surveys in the community)
- There is high public awareness of their availability (e.g., again based upon surveys in the community)
- They are low cost or free
- They are available year round and at least on weekends (e.g., rather than just during holiday periods)
- They provide rides to and from the drinking venues (e.g., rather than just a ride home so the drinker must leave their vehicle at the bar)
- They have many sponsors for funding in order to be sustainable (e.g., alcohol industry; hospitality industry; bars and restaurants in the community; auto dealerships; soft drink industry; insurance industry; etc.)
- They are perceived to be safe by the community (e.g., the AT drivers are careful drivers)

5.2. AT evaluations

If a community chooses to implement an AT program, it should be evaluated for its effectiveness as part of the intervention. This means collecting data before implementation, during the implementation, and after full implementation in the AT program community and in a similar comparison community without an AT program. To measure effectiveness the following should be in the design:

- Pre-Post Design (this will indicate whether measures of interest changed after the intervention (AT) went into effect)
- Intervention and Similar Comparison Community (this controls for other factors [other than AT] that could have an influence on our alcohol harm measures)

- Community Drivers Telephone/On-line Surveys of reported program awareness, attitudes, behaviors and alcohol consumption (while this is self-report data with certain limitations, it will indicate awareness of the intervention and any reported behavioral changes connected to the intervention (AT))
- Roadside Surveys where BACs on drivers and passengers are obtained (this will give us objective and quantitative measures of impaired driving before and after the intervention including in the comparison community)
- Crash Reports from Law Enforcement (pre- and post-intervention) (while alcohol involvement in police crash reports is underreported, a surrogate measure of alcohol, the ratio of single vehicle nighttime (SVN) crashes to multiple vehicle daytime (MVD) crashes will indicate changes before and after the intervention)
- DUI Arrests and other alcohol-related crime from Law Enforcement (pre- and post-intervention) (this will indicate changes in other harm due to alcohol associated with the intervention)
- Time Series/Regression Analyses (this is the appropriate and scientifically accepted statistical method of analyses)
- Results from Intervention Community relative to results from Comparison Community (this provides control over other extraneous factors that could be affecting our alcohol harm measures)

In addition to measuring effectiveness of AT programs, further research would be necessary to generate evidence to guide the design and implementation of programs in communities. To be useful, such research undertakings should be collaborative, drawing on data sources from multiple stakeholders involved and employing rigorous multidisciplinary approaches towards a rigorous and consistent assessment of results. Hypotheses tested would include: Relative to the comparison community, the intervention community (where alternative transportation is introduced) will experience lower DUI arrest rates, lower DUI crash rates, lower prevalence of drinking drivers on the roads and lower prevalence of reported drinking and driving with no significant change in alcohol consumption.

5.3. AT future

Automated vehicles (AVs) have the potential to substantially change the landscape on AT programs and on preventing impaired driving. While there are many issues surrounding AVs that need to be resolved, and they will be prominent in about 20 years, AVs will most certainly replace any other AT methods for the most part. It will be interesting to observe their use and safety when a significant number of AVs are on U.S. roads.

5.4. Effect of the pandemic

The COVID-19 pandemic has already significantly affected vehicle miles travelled and fatal crashes in the United States (e.g., Shilling & Waetjen, 2020). While there are not any currently published studies on the effect of the pandemic on impaired driving, it is probable that there has been a large effect. Most of the alcohol consumption in the United States in March, April and May 2020, has been at home. Bars and restaurants and most on-premise outlets have been shut down. Whatever impaired driving that has occurred has been initiated from home. Research on the effects of the pandemic on vehicle travel, crashes, impaired driving and traffic safety as a whole promises to shed light on these issues.

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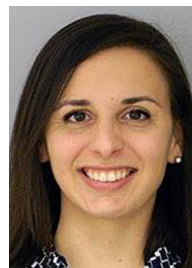
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