Road Traffic Injuries and Fatalities among Drivers Distracted by Mobile Devices

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Abstract

Context: With increasing ownership of mobile devices (i.e., cell phones and smartphones), it is important to better understand the role of these devices in motor vehicle collision (MVC)-related trauma. **Aims:** The primary objective was to synthesize evidence on the proportion of drivers injured or killed in an MVC attributed to driver distraction by a mobile device. As a secondary objective, we assessed for associations between injury risk and mobile device use while driving. **Settings and Design:** This study was a systematic review. **Subjects and Methods:** We searched five electronic databases (PubMed, Embase, CINAHL, TRIS, and Web of Science) and the gray literature to identify reports of drivers injured (regardless of the severity) or killed in MVCs attributed to mobile device-related distraction by the driver. We evaluated study and driver characteristics, as well as associations between injury risk and mobile device use by drivers. **Statistical Analysis Used:** Descriptive statistics were used to report study characteristics. The proportion of injuries related to driver distraction by mobile devices was calculated for each study. **Results:** Overall, 4907 articles were screened, of which 13 met eligibility criteria. The median proportion of distracted-driving-related trauma was 3.4% (range: 0.04% to 44.7%). Three studies evaluated the association between mobile device use and road traffic injury; all found use of a mobile device while driving significantly increased crash risk. **Conclusions:** The proportion of road traffic injuries and fatalities attributed to driver distraction by a mobile device ranges from 0.04% to 44.7%. Studies were subject to limitations in the collection of reliable data on distraction-related MVCs.

Keywords: Distraction, driving, injury, phone, trauma

Introduction

Distracted driving is a global public health concern that is largely preventable.[1,2] As ownership of mobile devices (i.e. cell phones and smartphones) has increased, so has the use of these devices while operating a motor vehicle. The prevalence of distracted driving related to mobile devices use has been reported to range between 1.3% and 31.4%.[3-9]

Earlier systematic reviews have examined the association between driving performance and secondary tasks,[10-12] and strategies to prevent motor vehicle injuries.[13] Our objective was to synthesize evidence regarding the proportion of drivers injured or killed in motor vehicle collisions (MVCs) that were attributable to driver distraction by a mobile device.

Subjects and Methods

This review was conducted in accordance with the Preferred Reporting Items for Systemic Reviews and Meta-analyses Guidelines.[14] The study protocol was registered with PROSPERO (PROSPERO 2016: CRD42016040088).

A search strategy was developed in collaboration with an experienced librarian and modified to search five electronic databases: PubMed, Embase, CINAHL, Web of Science, and the Transportation Research Information Services database. Searches were performed on June 7, 2016, and updated on September 15, 2017. Each database was searched from inception to the present day. The search strategy included a combination of MeSH terms, Emtree terms, and variations of keywords including "driver," "motor vehicle," "automobile," "distraction," "crash," "collision," "accident," "mobile,"

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"device," "phone," "smartphone," "cell phone," "texting," "injury," "trauma," "emergency," and "hospital," The PubMed search strategy can be found in Appendix 1. We also searched the gray literature on the same dates as the database searches using variations of keywords in Google and Google Scholar.

The inclusion criteria for this review were: (a) Design– any published report involving human subjects including case-control and cross-sectional studies, as well as reports from government and the private sector; (b) population– drivers of passenger vehicles, heavy vehicles, or motorcycles; (c) exposure– use of a handheld mobile device (i.e., cell phone, smartphone) while driving; and (d) outcome– injury or death in a traffic crash. Articles which did not differentiate between distraction by a mobile device and other forms of behavior while driving (e.g., eating, smoking, etc.) were excluded. We excluded articles if it was not possible to determine the proportion of drivers injured or killed in MVCs attributable to driver distraction by a mobile device. We also excluded studies that did not report data on actual injuries or fatalities (e.g., studies involving driving simulators). There were no limitations placed on injury severity or publication language. Any articles identified in languages other than English were translated using Google Translate.

The primary outcome was road traffic injury (regardless of severity) or death in drivers distracted by a mobile device before an MVC. In addition, we assessed for any information on hospital admissions, admissions to the Intensive Care Unit (ICU), and duration of hospital stay for injured drivers. We also sought to identify any association between risk of injury and use of a mobile device while driving.

Two reviewers independently screened the title and abstract of all studies identified from the literature search. Articles deemed not relevant based on title and abstract were excluded. For each remaining study, the full text was obtained and independently screened for eligibility by each of two reviewers. Any disagreements between reviewers were resolved through consensus. If consensus could not be reached, a third reviewer was consulted to resolve the disagreement. Bibliographies of all articles which met selection criteria were searched for additional relevant studies. Inter-rater agreement for article screening was calculated using nonweighted Cohen's kappa. Agreement interpretation was based on established categories: poor ($\kappa < 0.00$), slight (0.00–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80), and almost perfect (0.81–1.00).

Two-blinded reviewers independently assessed the quality of included studies using the Newcastle-Ottawa Quality Assessment Scale (NOS) for cohort and case–control studies.[15] Studies were evaluated based on their selection of study groups, their comparability, and their assessment of the outcome of interest. We included all studies that met our inclusion criteria regardless of their risk of bias. Weighted kappa was used to calculate inter-rater agreement for the total NOS scores.

A standardized data extraction form was created and used to collect data including study location, publication date, information sources, the definition of distracted driving, vehicle type, the total number of MVCs, the total number of injuries, and severity of injuries. We also extracted the following data if available: age, gender, type of mobile device, type of behavior (e.g., eating/drinking, talking, and texting), secondary outcomes (hospital admission, ICU admission, length of hospital stay), and any association between injury risk and mobile device use. Study authors were contacted directly if there was any uncertainty about their methodology or results.

Characteristics of included studies and drivers are reported using simple descriptive statistics. The proportion of distracted driving-related trauma was defined as the ratio of drivers injured or killed in mobile device-related MVCs to the total number of drivers injured or killed in MVCs. Associations between distracted driving and crash risk are reported descriptively. All analyses were performed using Microsoft® Excel (Microsoft Corp., Redmond, WA) and the R Statistical software package (V3.0.1; R Foundation for Statistical Computing, Vienna, Austria). Due to considerable variation among studies concerning their design, geography, inclusion criteria, and methods for determining that MVCs were related to distracted driving, it was not possible to perform a meta-analysis.

Results

Thirteen studies met all inclusion criteria. A total of 4907 articles were identified in our literature search, and an additional ten articles were found via bibliographic review and manual search of the gray literature [Figure 1]. Following removal of duplicates, the remaining 3494 articles were independently screened by two reviewers. Eighty-five articles were deemed relevant based on title and abstract screening, and underwent full-text screening by two reviewers; 72 were excluded due to ineligibility ($\kappa = 0.32$; fair agreement). The search strategy for PubMed can be found in Appendix 1.

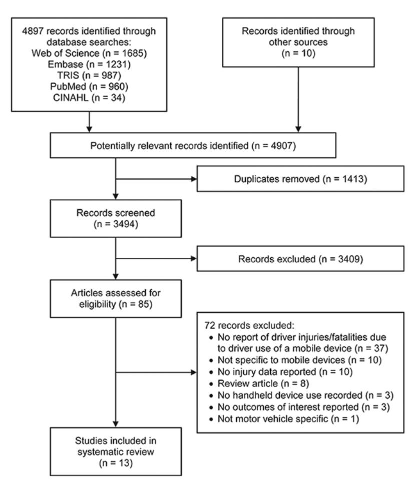

Figure 1: Selection of articles for inclusion

Table 1 shows characteristics of the 13 included studies. Studies were published between 1998 and 2017, with sample sizes ranging from 74 to 1,080,637. Five studies were performed in the United States,[16-20] three in Australia,[21-23] one in Canada,[24] one in Qatar,[25] one in the United Arab Emirates,[26] one in Iran,[27] and one in England and Wales.[28] In addition to mobile device use, other types of behavior evaluated including smoking,[23,25-27] eating/drinking,[25,26] as well as various internal[16,18,22-25,27,28] and external[16,22,23,26] distractions. Studies determined the involvement of driver distraction through examination of data collected from police reports,[16-20,22,23,28] interviews,[21,22,24,25-27] phone records,[19,21] medical records,[21,22,26] coroner reports,[19,22] and investigation of the scene and vehicle.[22]

Table 2 describes injuries related to driver distraction by mobile devices. Overall, the proportion of distracted driving-related trauma ranged from 0.04% (192/449,560) to 44.7% (162/358), with a median of 3.4%. Nonfatal MVC injuries related to mobile device use was specifically reported in six studies[16,17,21,24,25,27] and ranged from 0.04% (190/443,077) to 25.4% (104/409) with a median of 9.6%. MVC fatalities attributed to mobile device use was reported in five studies,[16,17,19,20,28] ranging from 0% (0/1) to 44.7% (162/358), with a median of 0.05%. Six studies reported on both injuries and fatalities;[16-18,22,23,26] three of these studies combined injuries and fatalities in their reporting.[18,22,23] Three studies only reported on fatalities due to distracted driving.[19,20,28] Injury severity was undefined in three studies.[18,23,27]

Some studies stratified distraction-related injuries by age group. Limrick *et al*. found that involvement of mobile devices in fatal/injury crashes in California between 2003 and 2011 was the most common in drivers aged 21–30 years.[18] Violanti reported a total of five MVC fatalities attributed to mobile device use by drivers in Oklahoma between 1992 and 1995, of which two were aged 21–29 years and three were aged >50 years.[20] Finally, Lam observed that most injuries/deaths related to handheld phone use were seen in the 25–29 years age group.[23] There was limited evidence reported regarding the gender of drivers involved in distraction-related MVCs. Violanti observed that a greater number of males

Table 1: Characteristics of included studies

Author (year)	Location	Study type	Data sources	Study duration	Sample size	Age (years)	Percentage male	Distraction types reported
Beanland, 2013	Victoria, NSW and Queensland, AUS	RC	INT, SVI, MED, POL, COR	April 2000-August 2011	938	Mean 41.2	52	Internal,* mobile device use, in-vehicle, external
Bener, 2012	Qatar	DS, CS	INT	January 2009-February 2010	1762	18+	69.4	Smoking, eating/drinking, mobile device use, SMS/text†
Brown, 2009	Alabama, USA	DS, QT	POL	2009 (5.5 months)	28,105	All ages	NR	Fatigue, mobile device use, in-vehicle, external
Brubacher, 2017	British Columbia, CAN	DS, QL	INT	NR	74	17-5	50	Mobile device use, in-vehicle, fatigue
Eid, 2017	Al-Ain City, UAE	PC	INT, MED	April 2006-October 2007	330	16-57	89.1	Mobile device use, talking with other passengers, using entertainment system, smoking, eating/drinking
Huang, 2002	North Carolina, USA	RC	POL	January 1996-August 2000	1,080,637	16+	58.1	Mobile device use
Lam, 2002	NSW, AUS	RC	POL	1996-2000	414,136	16+	NR	In-vehicle, external, hand-held mobile device use
Limrick, 2014	California, USA	DS, QT	POL	2003-2011	124,742	All ages	NR	Mobile device use, other inattention
McEvoy, 2005	Perth, AUS	CC	INT, MED, PHO	April 2002-July 2004	456	17+	42.1	Mobile device use
Pakula, 2013	California, USA	DS, QL	POL, COR, PHO	January 2009-June 2012	514	18-49	NR	Texting
Stevens, 2001	England and Wales	DS, QL	POL	1985-1995	5740	NR	NR	Mobile device use, passenger, inattention, other in-vehicle
Vafaee-Najar, 2011	Mashhad, Iran	CT	INT	June 2007-November 2007	312	Mean 37.4	80	Mobile device use, smoking, other in-vehicle
Violanti, 1998	Oklahoma, USA	CT	POL	1992-1995	1548	Mean 40.5	89	Mobile device use

*Internal distractions included sneezing, thinking, and feeling stressed, nervous, or pain, †Only included mobile phone use; data could not be obtained for drivers who used mobile phone and/or SMS/text. RC: Retrospective cohort, PC: Prospective cohort, DS: Descriptive study, CS: Cross-sectional, QT: Quantitative, QL: Qualitative, CC: Case-crossover, CT: Case-control, NSW: New South Wales, INT: Interviews, SVI: Scene/vehicle inspections, MED: Medical records, POL: Police reports, COR: Coroner reports, PHO: Phone records, NR: Not reported

Table 2: Injuries related to mobile device use while driving

Author (year)	Total number of MVCs with data on distraction*	Number of MVCs involving any distraction type†	Types of injury	Number of injured drivers overall (n)‡	Number of driver deaths overall (n)§	Number of mobile device-related injuries (percentage of n‡)	Number of mobile device-related deaths (percentage of n§)	Distracted driving-related trauma‖ (%)
Beanland, 2013¶	340	216	Minor to fatal	340	NR	3 (0.9)	NR	0.9
Bener, 2012	783	NR	Minor to severe	409	NR	104 (25.4)	NR	25.4
Brown, 2009	28,105	2620	Possible to fatal	895	12	87 (9.7)	0 (0)	9.6
Brubacher, 2017	74	9	Minor	74	NR	1 (1.4)	NR	1.4
Eid, 2017	330	44	Minor to fatal	330	1	19 (5.8)	0 (0)	5.8
Huang, 2002	1,080,637	425	Possible to fatal	443,077	6483	190 (0.04)	2 (0.03)	0.04
Lam, 2002¶	399,077	15,059	Injury (undefined) to fatal	63,779	NR	30 (0.05)	NR	0.05
Limrick, 2014¶	NR	124,742	Injury (undefined) to fatal	124,742	NR	4301 (3.4)	NR	3.4
McEvoy, 2005	456	456	Mild to moderate	423	NR	40 (9.5)	NR	9.5
Pakula, 2013	491	162	Fatal CNS injury	NR	358	NR	162 (44.7)	44.7
Stevens, 2001	5740	101	Fatal	NR	5740	NR	3 (0.05)	0.05
Vafaee-Najar, 2011	312	NR	Injury (undefined)	154	NR	23 (14.9)	NR	14.9
Violanti, 1998	1,548	5	Fatal	NR	1548	NR	5 (0.3)	0.3

*Number of MVCs with data regarding any type of distracted driving, †Number of MVCs attributed to any type of distraction, ‡Number of drivers injured in MVCs related to mobile device use, §Number of drivers killed in MVCs related to mobile device use, ‖Defined as the ratio of drivers injured (regardless of severity) or killed in a mobile device-related MVC to the total number of drivers injured or killed in MVCs that may have involved distracted driving, ¶Reported on injuries and fatalities combined. MVC: Motor vehicle collision, NR: Not reported, CNS: Central nervous system

were killed in MVCs related to mobile device use (four males and one female).[20] Limrick *et al*. also reported that males accounted for the majority of drivers involved in fatal/injury crashes attributable to mobile device use.[18]

Periods of data collection for individual studies spanned nearly three decades between 1985 and 2013 [Figure 2]. In the four studies that investigated MVCs occurring before 2000, the proportions of distracted driving-related trauma were 0.04% (192/449,560),[17] 0.05% (3/5,740),[28] 0.05% (30/63,779),[23] and 0.3% (5/1,548).[20] Studies of data on MVCs from 2000 or later observed proportions of distracted driving-related trauma between 0.9% (3/340) and 44.7% (162/358), with a median of 9.55%. We also assessed included studies for any association between injury risk and driver distraction by a mobile device [Table 3].

Using the NOS, we assessed the risk of bias for all included studies [Table 4]. A low NOS score reflects poor study quality. Overall, three studies had a total score of five,[24,25,27] eight had a score of six,[16-19,22,23,26,28] one had a score of seven,[21] and one had a score of eight.[20] Inter-rater agreement between the two reviewers was substantial (κ = 0.73).

Discussion

Our review of the literature identified 13 studies that reported on drivers injured or killed in MVCs that were attributable to driver distraction by a mobile device. Considering all injury severities from minor to fatal, the proportion of distracted driving-related trauma ranged from 0.04% to 44.7% (median 3.4%). Due to challenges with the collection of accurate data on distraction-related MVCs, these findings are likely to underestimate the actual prevalence of road traffic injuries related to mobile device use. Furthermore, increasing rates of cell phone ownership and on-going advances in technology make it difficult to compare the prevalence of distracted driving-related trauma over time. Despite these limitations, the evidence synthesized in this review highlights the danger posed by the use of a mobile device while driving, both to individual drivers and to the public at large.

With the dramatic increase in mobile device ownership over the past few decades, it is hard to compare earlier studies with those performed more recently. This is especially true since the functionality of these devices has evolved from performing simple actions such as making and receiving phone calls to texting, E-mailing, social media, real-time pictures and video, and countless other applications. One of the main challenges with investigating distraction-related MVCs is that researchers are often left to rely on police reports to determine if mobile device use was a contributing factor, since most jurisdictions prohibit the dissemination of data on phone use to third parties without the customer's consent. Unfortunately, the data available in police reports is known to be unreliable.[29] Without witnesses or an admission of guilt by a distracted driver, it is challenging for police officers to determine if the primary cause of an MVC was distraction by a mobile device, especially if the driver did not survive the collision. Research from the United Kingdom suggests that information stored in iPhone's CurrentPowerlog. powerlog and Android's buffer logs can show a driver's direct or passive activity on their mobile device, which can be used to provide an explanation

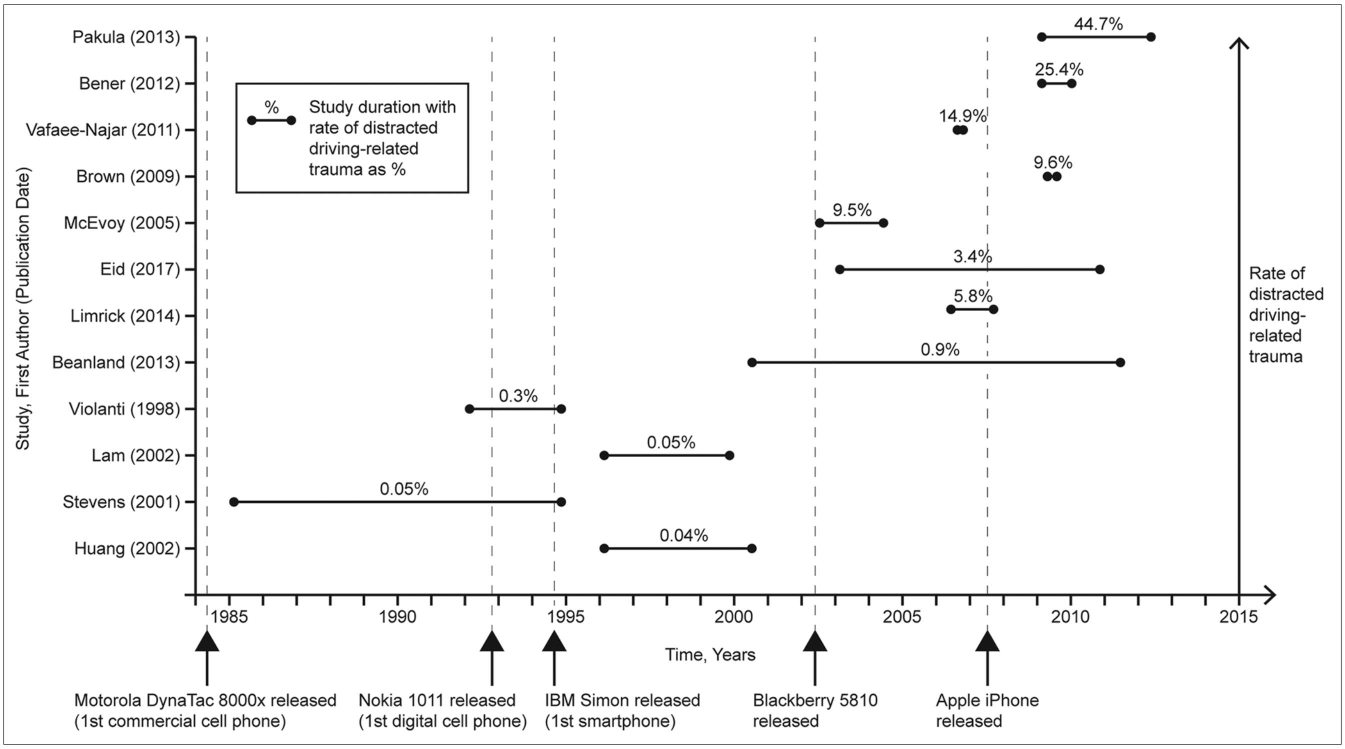

Figure 2: Duration of included studies over time. Study time periods shown with proportions of distracted driving-related trauma and milestones in the evolution of mobile devices. Note: Brubacher (2017) is not shown (study time period was unavailable)

Table 3: Association between injury risk and mobile device use while driving

Author (year)	OR/RR	Explanatory variables
Lam, 2002	RR of injury or death in a car crash for 25-29 years age group who used a hand held phone was 2.4 times higher compared to crashed drivers without any distraction (RR=2.37, 95% CI: 1.31-4.27). No significant increase in risk of injury/death was observed with hand held phone use in any other age group	NR
McEvoy, 2005	Mobile phone use in hazard interval during and up to 10 min before estimated time of crash was associated in increased likelihood of crashing (OR=4.1, 95% CI: 2.2-7.7)* compared with phone use by same driver during control intervals; similar increase in likelihood for phone use during and up to 5 min before crash (OR=3.6, 95% CI: 1.8-7.0)*; risk of crash was increased irrespective of phone type (hand held [OR=4.9, 95% CI: 1.6-15.5, P=0.003] vs. hands-free [OR=3.8, 95% CI: 1.8-8.0]*)	Hazard interval compared with control intervals‡
Violanti, 1998	Risk of fatal collision was significantly associated with presence of a phone (AOR=2.11, 95% CI: 1.64-2.71)† and use of a phone (AOR=9.29, 95% CI: 3.70-23.14)†; with phone in use, risk of fatal collision was significantly associated with being male (AOR=1.64, 95% CI: 1.61-2.74)†, increasing age (AOR=2.23, 95% CI: 1.12-6.37)†, alcohol/drug involvement (AOR=2.83, 95% CI 1.28-6.17)†, and driving left of center (AOR=14.35, 95% CI: 8.49-23.79)†; interaction models showed significantly increased risk of fatal collision when phone use was combined with covariates of being male (AOR=1.84, 95% CI: 1.13-16.4)†, speeding (AOR=5.73, 95% CI: 4.48-54.5)†, inattention (AOR=2.01, 95% CI: 1.04-3.81)†, and driving left of center (AOR=36.50, 95% CI: 3.31-330.1)†	Age, gender, mobile phone, alcohol/drug involvement, speeding, inattention, driving left of center

*Significant at $P<0.001$. †Significant at $P<0.05$. ‡Control intervals were same time and duration 24 h, 72 h, and 7 days before crash when drivers confirmed they had been driving. RR: Relative risk, OR: Odds ratio AOR: Adjusted OR, CI: Confidence interval, NR: None reported

for the events leading up to a crash.[30] Although numerous laws and regulations have been enacted worldwide to address the use of mobile devices while driving, enforcement remains a challenge.[1,31] Another challenge is in determining culpability for a crash. Researchers in Canada have shown that use of a mobile device by drivers increases the odds of a culpable crash by 70% compared to drivers who did not use a mobile device.[32]

Recent observational studies of driver distraction by mobile devices have observed rates as low as 1.3% in Spain[8] and as high as 33% in the United States.[4] Survey data suggest the prevalence may be closer to 47% in India,[33] 52% in Canada,[34] and 69% in the United States.[35] Millennials (18–34 years of age) are more likely to be mobile device users compared with those aged 35 years and older,[36] and research has consistently shown that younger drivers (<30 years) engage in distracting activities more often than older drivers.[4-6,8,9] Similarly, the findings of our review suggest that distracted driving-related trauma is most common among relatively

Table 4: Quality assessment using the Newcastle-Ottawa Scale

NOS Author (year)	Selection				Comparability		Outcome			Total score
	1	2	3	4	5	6	7	8	9	
Case-control*										
McEvoy, 2005	★	-	★	-	★	★	★	★	★	7
Vafaee-Najar, 2011	-	-	★	-	★	★	-	★	★	5
Violanti, 1998	★	★	★	-	★	★	★	★	★	8
Cohort†										
Beanland, 2013	★	★	★	-	-	-	★	★	★	6
Bener, 2012	★	★	★	-	-	-	-	★	★	5
Brown, 2009	★	★	★	-	-	-	★	★	★	6
Brubacher, 2017	★	★	★	-	-	-	-	★	★	5
Eid, 2017	★	★	★	-	-	-	★	★	★	6
Huang, 2002	★	★	★	-	-	-	★	★	★	6
Lam, 2002	★	★	★	-	-	-	★	★	★	6
Limrick, 2014	★	★	★	-	-	-	★	★	★	6
Pakula, 2013	★	★	★	-	-	-	★	★	★	6
Stevens, 2001	★	★	★	-	-	-	★	★	★	6

Articles were assessed for risk of bias using the NOS for *case-control or †cohort studies. NOS: Newcastle-Ottawa Scale, ★: The study has met the criteria for a domain of the Newcastle-Ottawa Scale, -: The criteria were not met

inexperienced drivers, with the greatest proportion of road traffic injuries and deaths seen in the 20–30 years age group. Furthermore, Lam found the relative risk (RR) of injury or death in crashed drivers who were using a handheld phone (compared to crashed drivers with no distraction) was significantly higher in drivers aged 25–29 years (RR = 2.37), but not in any other age group.[23] It is important to note that our search strategy was designed to identify articles which addressed our primary objective and not necessarily our secondary objective; thus, we excluded studies which evaluated crash risk associated with mobile device use but did not investigate injuries or deaths. In one such study, Neyens and Boyle examined the influence of distracted driving on the severity of injuries in teenage drivers and their passengers; being distracted by a mobile device increased the likelihood of severe injury in drivers (adjusted odds ratio [AOR] = 1.27), female drivers (AOR = 1.43), and occupants (AOR = 4.69).[37] Although younger drivers are more likely to be using their phones while driving, older drivers who use mobile devices while driving are also at considerable risk of collision due to age-related degradation in reaction time, perception, cognition, and ability to handle competing activities. An analysis of distracted drivers and nondistracted drivers from the same age groups and found the likelihood of severe injury in younger drivers (<25 years) was highest when talking on a cell phone (OR = 1.33), while the likelihood of severe injury in older drivers (≥65 years) was the highest when dialing or texting on a cell phone (OR = 4.78).[38]

Research has consistently shown that the crash risk in drivers who text is higher than that of drivers who talk on a phone. Not surprisingly, the highest proportion of distracted driving-related trauma we found (44.7%) was from the only study that focused on text messaging among drivers involved in MVCs.[19] There is evidence that texting while driving has contributed to a significant increase in the number of deaths from MVCs. Wilson and Stimpson determined that upward trends of texting in the United States resulted in an estimated 16,141 additional fatalities from distracted driving between 2001 and 2007.[39] In their meta-analysis on the impact of typing and reading text messages on driving performance, Caird *et al*. found that the largest effect sizes were for eye movements during typing alone, followed by typing and reading.[10] Although drivers who texted appeared to go slower and increase the distance between themselves and vehicles ahead, these behaviors did not compensate for the visual, cognitive, and physical distractions associated with prolonged and repeated glances to read and type text messages. Texting reduced the ability of drivers to respond to traffic events, direct adequate attention to the road, and control their vehicle in a lane and with respect to other vehicles. In another meta-analysis, Simmons *et al*. compared the risk of a safety-critical event (SCE) between the tasks of talking, dialing, locating/answering, or texting/browsing with a mobile device while driving.[11] Risk of a SCE was increased for texting/browsing (OR = 10.30), dialing (OR = 4.04), and locating/answering a mobile device (OR = 3.57); however, talking on a mobile device while driving was associated with a statistically insignificant OR of 0.89. These differences in risk may be explained in part by the amount of time drivers need to remove their eyes from the road to perform these tasks. Additional research is required to better understand the prevalence of road traffic injuries and fatalities due to driver behaviors that require prolonged and repetitive distraction from the roadway such as texting, E-mailing, and browsing.

This review has several important limitations that must be considered when interpreting the results. First and foremost, there are inherent challenges with collecting reliable data on distraction-related MVCs. Indeed, most studies acknowledged that their results were likely to underestimate the actual prevalence of injuries or deaths due to driver distraction by a mobile device. Reasons given for this potential under-reporting included driver, passenger, or witness recall bias,[24,25,28] reporting bias by culpable drivers avoiding consequences for their actions,[18,21,24] incomplete databases records,[17,22] and misinterpretation of data by accident researchers.[28] It is also possible that injured drivers who were using a mobile device immediately before their MVC may have disproportionately chosen not to participate in an investigation of distracted driving. Most studies in this review used data from police reports which are known to be unreliable as discussed earlier. Although phone records may potentially help determine whether mobile device use contributed to an MVC, these records are difficult to obtain (only two studies collected information from phone records) and they may not contain information on all possible forms of distraction-related to mobile device use (e.g., locating the device, dialing a number). In addition, there was considerable variation in methods used to collect data on distraction-related MVCs. Importantly, advances in technology and increases in mobile device ownership make it difficult to compare rates of distracted driving-related trauma over time; thus, our reported median proportion of 3.4% should not be used to reflect what is happening on the roads today. It also bears remembering that MVCs tend to be multifactorial events; thus, it is difficult to attribute the cause of a given MVC solely to driver distraction by a mobile device since there may have been other factors that played a larger role in the collision.

Conclusion

In summary, previous investigations have determined that road traffic injuries and fatalities among drivers were attributed to distraction by mobile devices in 0.04% to 44.7% of cases (median 3.4%). These studies were subject to significant methodological limitations in the collection of reliable data and may not reflect current rates of distracted driving-related trauma. As cell phone ownership increases and technologies continue to advance, further investigation on traumatic injuries due to driver distraction by mobile devices is warranted.

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Conflicts of interest

There are no conflicts of interest.

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Appendix

Appendix 1:

PubMed search strategy:

((motor vehicles[mh]) OR (driv*[tiab]) OR (motor[tiab]) OR (vehicle*[tiab]) OR (traffic[tiab]) OR (automobile*[tiab]) OR (truck*[tiab]) OR (motorcycle*[tiab])) AND ((Smart phone[mh]) OR (cell phone[mh]) OR (text messaging[mh]) OR (computers, handheld[mh]) OR (distract*[tiab]) OR (cellphone*[tiab]) OR (mobile phone*[tiab]) OR (mobile device*[tiab]) OR (smartphone*[tiab]) OR (tablet*[tiab]) OR (handheld[tiab]) OR (text*[tiab]) OR (messag*[tiab]) OR (calling[tiab]) OR (phone call*[tiab])) AND ((accidents, traffic[mh]) OR (Trauma centers[mh]) OR (traumatology[mh]) OR (wounds and injuries[mh]) OR (injuries[mh]) OR (hospitalization[mh]) OR (emergency service, hospital[mh]) OR (emergency medicine[mh]) OR (critical care[mh]) OR (trauma severity indices[mh]) OR (trauma*[tiab]) OR (emergency room*[tiab]) OR (ER[tiab]) OR (EM[tiab]) OR (injur*[tiab]) OR (fatal*[tiab]) OR (death*[tiab]) OR (mortality[tiab]) OR (hospital*[tiab]) OR (admission*[tiab]) OR (admit*[tiab]) OR (emergenc*[tiab]) OR (MVC*[tiab]) (crash*[tiab]) OR (collision*[tiab]) OR (accident*[tiab]))