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ACCIDENTS AND VIOLENCE

Cell phone use and traffic crash risk: a culpability analysis

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Background The use of a cell phone or communication device while driving is illegal in many jurisdictions, yet evidence evaluating the crash risk associated with cell phone use in naturalistic settings is limited. This article aims to determine whether cell phone use while driving increases motor vehicle crash culpability.

Method Drivers involved in crashes where police reported cell phone use ($n = 312$) and propensity matched drivers (age, sex, suspect alcohol/drug impairment, crash type, date, time of day, geographical location) without cell phone use ($n = 936$) were drawn from Insurance Corporation of British Columbia Traffic Accident System data. A standardized scoring tool, modified to account for Canadian driving conditions, was used to determine crash culpability from police reports on all drivers from the crashes. The association between crash culpability and cell phone use was determined, with additional subgroup analyses based on crash severity, driver characteristics and type of licence.

Results A comparison of crashes with vs without cell phones revealed an odds ratio of 1.70 (95% confidence interval 1.22–2.36; $P = 0.002$). This association was consistent after adjustment for matching variables and other covariates. Subgroup analyses demonstrated an association for male drivers, unimpaired drivers, injured and non-injured drivers, and for drivers aged between 26 and 65 years.

Conclusions Crash culpability was found to be significantly associated with cell phone use by drivers, increasing the odds of a culpable crash by 70% compared with drivers who did not use a cell phone. This increased risk was particularly high for middle-aged drivers.

Keywords Cell phones, driving, traffic crashes, culpability

Introduction

Studies from Canada, Australia and the USA have shown that the self-reported prevalence of cell phone use while driving is on the rise, particularly texting while driving,[1–4] and that young people are particularly inclined to this.[5] Roadside studies indicate that, on average, 2–5% of drivers were observed using a cell phone behind the wheel,[6–8] whereas a US national survey found that drivers were talking, on average, 7% of the time while they were driving.[4]

Although crash rates in many jurisdictions remain stable or have declined, the proportion of crashes in which a cell phone has been involved has risen.[9,10] Determining the costs of cell phone-related crashes remains a challenge; however, one estimate suggests that a national ban on cell phone use while driving in the USA would have prevented ~22% of crashes in 2008.[4] A recent report drawing on trends in fatal collisions and mobile device use estimated that >16 000 additional road fatalities, from 2002 to 2007, occurred in the USA as a result of texting on a mobile device. It is not surprising, then, that policies restricting the use of cell phones and other mobile devices while driving are in place in many jurisdictions across the globe.[11]

These policy efforts have been backed by experimental research examining the effects of cell phone use on driver performance. Three recent meta-analyses have synthesized the copious body of experimental research[1,12,13] and have concluded that cell phone use produces significant deficits in reaction times, tracking performance and attention, and that these deficits are equivalent for hand-held and hands-free devices, and across age groups.[14] Simulator studies, largely applying cognitive tests to small groups of drivers, have demonstrated that cell phone use negatively affects reaction times, with deficits that compare with those observed in drivers with a blood alcohol level of 80 mg/100 ml.[1,15–17]

However, the most important outcome associated with cell phone use while driving is whether its use leads to an increase in the risk of a crash and, in turn, crash-related injury. Experimental studies, although excellent at identifying the mechanisms that affect performance, are not able to fully mimic the complexity of naturalistic driving conditions that most drivers experience daily.[18–20] Comparatively, little epidemiological research has examined the relationship between cell phone use and crash risk.[21]

A meta-analysis of epidemiological studies of cell phone use and crash risk identified only six studies, of varying research designs, with a reasonable measure of pre-crash cell phone use,[22] and found that cell phone use increased the odds of a crash by 2.86 [95% confidence interval (CI) 1.72–4.75]. Of these, the level of precision in the assessment of cell phone use at the time of the collision varied from a review of cell phone billing records,[23,24] police reports[25] and in-car camera[26] to driver self-report.[27,28]

The two most carefully designed studies used case-crossover designs,[23,24] where each subject serves as their own control, and researchers compare exposure to a transient risk factor (e.g. cell phone use) at the time the outcome of interest (e.g. a crash) occurred, with exposure during a control time period.[20,29] Using this design, Redelmeier and Tibshirani[23] and McEvoy *et al*.[24] found a 4-fold increase in crash risk at times when a cell phone was used. This within-person design has much strength, yet not all confounding can be controlled for in a case-crossover design, particularly differences in driving environment, road type, time of day and weather, between exposure and control periods.[22] These studies also lack a crash-free control group, limiting generalizability, as all drivers must have been in a crash to be included in the study (crash-reporting centre, emergency departments).[30]

Another approach to examine cell phone crashes is through a crash culpability analysis. Culpability analysis draws on in-depth data collected from police or traffic engineering reports to assign responsibility to the drivers involved in a crash. These assessments are based on driver actions, the driving environment, traffic flow, road surface, weather conditions and other indicators. When a suitably 'harsh' method of assigning culpability is used, drivers deemed not culpable or responsible for their crash are likely to have done everything correctly during the driving event, and the crash was because of events that were entirely beyond their control. In this situation, non-culpable drivers are believed to closely approximate crash-free drivers.[31–34]

The objective of the current study is to estimate the association between cell phone use and driver culpability in a sample of drivers involved in crashes from 2005 to 2008 in British Columbia. The current study builds on the epidemiological research examining the impact of cell phone use on crash risk in naturalistic driving conditions while addressing some of the weaknesses of previous studies.

Methods

Study population

Our data are drawn from the British Columbia Traffic Accident System (TAS), which contains data from all police-attended traffic crashes in the province. This database is maintained by the Insurance Corporation of British Columbia and collects data on ~50 000 crashes per year. When police investigate a traffic crash, they fill out a structured two-page form where they document details of the crash, including the type of crash, the pre-crash action of each vehicle, the location of damage on each vehicle, weather conditions and road type. Police also document factors that they conclude contributed to the crash. These include 'human condition', 'human action', 'environmental condition' and 'vehicle condition'. Each entry is selected from a list of possible choices.

TAS data for the current study are from the years 2005–2008, totalling >180 000 crashes. From this data pool, a number of inclusion criteria are applied. First, crashes must involve a driver of a passenger vehicle, including passenger car (with and without trailer), sport utility vehicle (with and without trailer), panel van 4500 kg and under (includes mini vans) with and without trailer, single unit truck/light pickup truck, truck/camper/trailer and motor home. Excluded were motorcycles, large vehicles (trucks) and off-road vehicles. Second, crashes must not have involved a hit and run. Third, index drivers of crashes must not contain missing data in any fields used to determine culpability, exposure status or covariates. This left a pool of 118 447 crashes.

Measurement of cell phone use

Culpability analysis typically uses a case–control design[35]; however, we modified the design by first selecting drivers based on exposure status (cell phone use) before determining crash culpability. This was done because of the small number of crashes in which cell phone use was explicitly noted in the TAS data.

Exposed drivers are identified by police as having used a cell phone or communication device at the time of the crash, either through police observation or from driver and witness accounts. A total of 312 drivers were identified as having used a cell phone or a communication device and who satisfied the abovementioned inclusion criteria. Insurance Corporation of British Columbia has completed validation work, showing that 'communication devices' identified in the police report are almost exclusively cell phones.[36] There were several thousand drivers who were identified with an internal distraction, but police did not specify that cell phones were present. There were likely many other crashes where cell phone use was missed by police. As such, our exposed group represents only those drivers explicitly identified as using a device at the time of the crash. No distinction was made for hands-free devices.

Exposure matching

To avoid the impracticality of performing culpability analyses on all crashes, a three-to-one matching approach was used to select 936 crashes where the driver did not use a cell phone, drawn from a pool of 118 477 drivers in crashes meeting the inclusion criteria. A propensity score-matching procedure was used, drawing on the following seven crash-related variables: crash date (the exact date of the crash), crash time (coded as 12:00–5:59 am, 6:00–11:59 am, 12:00–5:59 pm, and 6:00–11:59 pm to capture times of peak crash risk), number of vehicles involved in the crash (one, two or more than two vehicles), road type where the crash occurred (highway, urban road, rural road), driver sex, driver age (16–20, 21–25, 26–40, 41–65, ⩾66 years) and suspected driver alcohol/drug use. Propensity scores were obtained through logistic regression, with exposed and unexposed matched using a nearest neighbour approach. The full range of propensity scores estimated was 0.0023–0.0093, whereas the average absolute difference in propensity scores between matched groups was 0.0032 (range: 0.0004–0.0086). As Table 1 indicates, there were no differences between the exposed and unexposed samples across matching variables. However, the propensity matched sample was different from the remaining unmatched control subjects for all measures, with the exception of the number of vehicles in the crash and whether the crash involved an injury.

Measurement of driver culpability

Driver culpability was assigned using a 'harsh' culpability scoring tool that we developed and validated.[37] Our tool was modified from the widely used 'Robertson–Drummer' scale,[38] and it accounted for Canadian driving conditions. A harsh scoring tool sets a higher standard for non-culpability, looking to determine whether the driver should have been able to avoid the crash—not merely whether they caused it. According to Af Wahlberg,[32] the benefit of harsh culpability scoring tools is that non-culpable drivers are expected to have the same risk factor profile as crash-free drivers on the road at the time of the crash.[33]

The culpability scoring tool considers seven categories when determining responsibility for the crash: road type, driving conditions (road surface, visibility and weather), vehicle condition, unsafe driving actions, contribution from other parties, type of collision and task involved (Supplementary Table S1, available as Supplementary data at *IJE* online). Each category is given a score ranging from 1 (favourable conditions) to 5 (unfavourable conditions).[37] Scores for these categories are added and used to assign drivers to one of three categories denoting their level of responsibility for the crash. Low total scores ($\leqslant 13$) indicate that there is no apparent reason for the crash beyond poor driver performance, and the driver is deemed culpable. Scores from 13.1 to 15.9 are considered to be indeterminate. Scores of $\geqslant 16$ indicate that the crash was because of factors other than performance of the driver, and the driver is deemed not responsible. Assessment of reliability and content validity, concurrent validity and predictive validity of our culpability scoring tool was done in three ways. First, content validity was ensured during its development through consultation with traffic experts on scoring tool components and weighting. Second, concurrent validity was demonstrated by comparing the culpability scoring tool with the assessment of two experienced crash investigators from Transport Canada. These experts reviewed the crash data and, for each driver, provided their opinion as to whether they could reasonably have avoided the crash. The final κ score between crash investigators' consensus ratings and the culpability scoring tool was high ($k = 0.83$; 95% CI 0.75–0.91). Finally, we demonstrated that the scoring tool had predictive validity by applying it to a large sample of crashes with known driver blood alcohol concentration levels and confirmed that, compared with non-culpable drivers, culpable drivers were more likely to have the risk factors known to be associated with crashing (alcohol use, young drivers, male drivers and drivers with a

Table 1 Descriptive statistics for cell phone crashes, matched non-cell phone crashes (using both approaches) and all non-cell phone crashes

	1		2		χ^2	3	χ^2	4	
	Exposed (cell phone) ($n = 312$)		Propensity matched unexposed (no cell phone) ($n = 936$)		1 vs 2	Non-matched unexposed ($n = 117\,541$)	2 vs 3	Crash-matched unexposed (no cell phone) ($n = 936$)	
Variables	n (%)	Percent culpable	n (%)	Percent culpable	P-value	n (%)	P-value	n (%)	Percent culpable
Male	203 (65.1)	68.9	621 (66.3)	62.6	0.68	72 694 (61.8)	0.01	602 (64.3)	69.2
Age (years)									
16–20	62 (19.8)	60	180 (19.8)	68.3	0.80	16 349 (13.9)	0.00	126 (13.5)	80.1
21–25	55 (17.6)	61.8	172 (18.4)	65.1	0.77	15 348 (13.1)	0.00	125 (13.3)	80.6
26–40	105 (33.6)	73.3	327 (34.9)	61.2	0.68	30 443 (25.9)	0.00	245 (26.2)	66.6
41–65	77 (24.6)	66.2	220 (23.5)	54.1	0.67	40 338 (34.3)	0.00	335 (35.8)	62.7
⩾66	13 (4)	61.5	37 (4)	67.5	0.87	15 093 (12.8)	0.01	105 (11.2)	81.2
Licence status									
Graduated driver's licence	85 (27.2)	61.2	236 (25.2)	65.2	0.48	23 835 (20.3)	0.02	179 (19.2)	74
Full licence	227 (72.7)	68.3	700 (74.8)	60.7		93 706 (79.7)		757 (80.8)	68.4
Suspected alcohol/drugs use	58 (19.3)	74.1	172 (18.4)	75.6	0.93	13 565 (11.5)	0.00	114 (12.2)	83.3
Crash-related injury	149 (47.7)	69.1	393 (42)	67.4	0.07	49 004 (41.7)	0.99	404 (43.6)	69.8
Number of vehicles in crash									
One	138 (44.2)	69.6	390 (41.7)	62.8	0.43	45 416 (38.6)	0.07	414 (44.2)	67.4
Two	148 (47.4)	61.5	479 (51.7)	60.9	0.25	62 709 (53.4)	0.21	444 (47.4)	70.5
Three or more	26 (8.3)	76.9	67 (7.2)	62.7	0.49	9416 (8.0)	0.36	78 (8.3)	73.1
Time period									
12:00–5:59 am	48 (15.4)	70.8	146 (15.6)	64.4	0.93	12 808 (10.9)	0.00	118 (12.6)	72.2
6:00–11:59 am	67 (21.0)	64.2	173 (18.5)	56.6	0.25	31 294 (26.6)	0.00	237 (25.3)	66.7
12:00–5:59 pm	98 (31.5)	71.4	312 (33.0)	65.1	0.52	46 320 (39.4)	0.00	316 (33.8)	73.1
6:00–11:59 pm	99 (31.7)	60.6	305 (32.5)	60.3	0.78	27 119 (23.1)	0.00	236 (25.2)	69.3
Road type									
Provincial highway	84 (27)	70.2	228 (24.4)	58.3	0.36	35 055 (29.8)	0.00	242 (26)	67.8
City/municipal road	206 (66)	63.1	631 (67.4)	63.7	0.65	75 873 (64.6)	0.04	649 (69)	70.4
Rural road	22 (7)	81.8	77 (8.2)	57.1	0.51	6613 (5.6)	0.01	45 (4.8)	62.2
Culpable crash									
Yes	207 (66.3)		579 (61.8)		0.15	Not scored		543 (58.1)	
No	53 (16.9)		252 (26.9)		0.00			305 (32.6)	
Indeterminant	52 (16.7)		105 (11.2)		0.01			88 (9.4)	
Mean culpability score (SE)	12.8 (0.17)		12.9 (0.13)		0.45	Not scored	—	13.2 (0.14)	

graduated licence).[37] These findings demonstrate that our culpability scoring tool meets Af Wahlberg's criteria for being 'harsh'.[32]

Unlike previous culpability scoring tools, our tool analysed electronic police reports and was semi-automated, using a computer algorithm. Police reports for this study were not free text—each item in the report has only a handful of possible responses. For example, under 'vehicle condition', police have the opportunity to list any of 18 possible vehicle factors that may have contributed to the crash (such as 'accelerator defective' or 'steering failure'). Our scoring tool assigns scores for each of the items relevant to each contributory factor. Scoring does not involve reading the individual police reports. Scores are assigned for each factor based on the presence or absence of specific items relevant to that factor. For example, all reports where police indicate that one of the 18 'vehicle conditions' contributed to the crash are given a score of 5 under the 'vehicle condition' factor. Conversely, if none of these vehicle conditions are indicated then the score for 'vehicle condition' is 1. These features reduce the risk of bias associated with manually scoring free text police reports where the reviewer is aware of the exposure status of the driver being scored and overcomes weaknesses of previous culpability studies.[39]

Another important source of bias in this study could occur if traffic police believe that drivers who use a cell phone are distracted, and this belief is reflected in the police report. We minimized the risk of this bias by ensuring that our scoring tool considers only items of the police report that are unlikely to be affected by this source of bias. For example, a snow-covered road or a left turn or front end damage on a vehicle should be recorded as such in the police report regardless of whether the driver was using a cell phone. We also ensured that, for this study, our tool does not consider cell phone use and also disregards 'driver error/confusion', 'driver inattentive' and 'driver internal/external distraction'. Police may document these factors as contributing to the crash, but their presence does not change the scoring. The actions considered under the 'unsafe driving' factor are dangerous manoeuvres that we believe police will list whenever present—regardless of cell phone use. For example, we believe that police will indicate that a driver was 'cutting in' or 'ignoring traffic control devices' regardless of whether he or she was using a cell phone.

Statistical analysis

To assess the impact of cell phone use on crash culpability, we estimated odds ratios (ORs), using a logit regression model with the robust cluster variance estimators. Crude and adjusted ORs (AORs) were calculated, with the inclusion of matching variables as control subjects in the adjusted model. Separate adjusted analyses examined age and licence status given collinearity. Subgroup analysis was performed comparing cell phone crash culpability by driver age, driver sex and suspected alcohol/drug use, as well as on whether the crash involved an injury. All analyses were completed using Stata11.1.[40] The project was reviewed and approved by the Dalhousie University Research Ethics Board.

Results

Crash culpability was assessed in the 312 exposed and 936 unexposed drivers. As seen in Table 1, overall, 66% ($n = 207$) of cell phone drivers were deemed culpable for their crash, 17% ($n = 53$) were deemed non-culpable and 16.6% ($n = 52$) were indeterminate, a distribution in line with other culpability studies using harsh scoring tools.[32,41] In terms of non-cell phone drivers, 62% ($n = 579$) of the propensity matched sample were deemed culpable. Indeterminates were removed from the main analysis. Given the matching design, when exposed drivers were removed, matching unexposed drivers were also removed. This left a final data set of 1091 (260 exposed, 831 unexposed) for the propensity matched analysis.

Table 2 presents logit regression results for the association between cell phone use and crash culpability. Unadjusted results (Model 1) indicate that the odds of a culpable crash were higher for drivers who had used a cell phone (OR 1.70, 95% CI 1.22–2.36; $P = 0.002$). This association remained in the adjusted models regardless of whether age (Model 2) (AOR 1.75, 95% CI 1.24–2.47; $P = 0.001$) or graduated licence status (Model 3) (AOR 1.74, 95% CI 1.23–2.43; $P = 0.001$) were included in the model. ORs for the association between cell phone use and crash culpability across subgroups are presented in Figure 1. Cell phone use was inconsistently associated with culpable crashes for certain subgroups; there was no observed association for female drivers, younger drivers (aged 16–20, 21–25 years) and older drivers (aged 66–80 years), as well as drivers in the graduated licensing programme, and those drivers suspected of alcohol/drug use.

Additional analysis (Table 2) was performed with a second-matched sample, using a three-to-one matching approach drawing on four crash-related variables.[42,43] Drivers who crashed while using cell phones use were matched on: crash date, crash time, number of vehicles involved in the crash and road type where the crash occurred. The AORs for the crash-variable model (Model 4) (AOR = 1.82, 95% CI 1.26–2.62; $P = 0.01$) were similar to those from the propensity-matched models.

Finally, given differences in the proportion of indeterminants between exposed and unexposed drivers, a sensitivity analysis was performed on the propensity matched sample by including indeterminants in the culpable group. Results indicate that when indeterminants are included with the culpable group, the association is significant (OR 1.80, 95% CI 1.30–2.48) and similar to main findings.

Discussion

The primary aim of this study was to assess the impact of cell phone use on crash risk in a naturalistic driving setting. It was determined that cell phone use

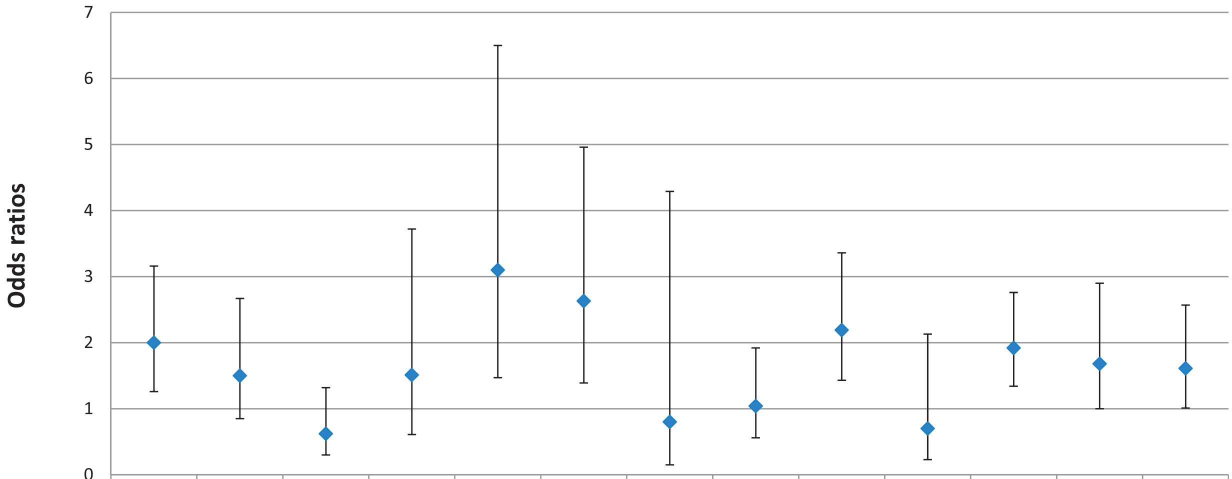
Table 2 Logit regression of crash culpability on cell phone use (OR and 95% CIs presented) for propensity matched and crash-variable-matched samples (adjusted for covariates)

Variables	Model 1 Propensity matched unadjusted model $n = 1091$	Model 2 Propensity matched adjusted model with age $n = 1091$	Model 3 Propensity matched adjusted model with licence status $n = 1091$	Model 4 Crash-variable-matching[a] adjusted model with age $n = 1088$
Cell phone use	1.70 (1.22–2.36)**	1.75 (1.24–2.47)**	1.74 (1.23–2.43)**	1.82 (1.26–2.62)**
Male		1.29 (0.98–1.72)	1.31 (0.99–1.74)	0.91 (0.68–1.20)
Age (years)				
16–20		1.84 (1.22–2.78)**		2.46 (1.46–4.15)**
21–25		1.67 (1.07–2.58)**		2.07 (1.28–3.34)**
26–40		1.39 (0.99–1.95)		1.21 (0.87–1.68)
41–65		1		1
⩾66		1.91 (0.96–3.79)		2.17 (1.18–4.07)*
Licence status				
Graduated drivers license		—	1.17 (0.83–1.66)	—
Full licence			1	
Suspected alcohol/drugs use		4.34 (2.53–7.45)**	4.33 (2.52–7.44)**	3.75 (2.08–6.76)**
Number of vehicles in crash				
One		1	1	1
Two		1.02 (.074–1.42)	0.98 (0.71–1.36)	1.00 (0.72–1.38)
Three or more		1.01 (0.58–1.75)	1.01 (0.59–1.74)	1.58 (0.88–2.83)
Time period				
12:00–5:59 am		1.27 (0.82–1.99)	1.36 (0.87–1.22)	1.07 (0.66–1.74)
6:00–11:59 am		1.25 (0.86–1.81)	1.20 (0.83–1.73)	1.04 (0.73–1.49)
12:00–5:59 pm		1.62 (1.15–2.28)**	1.59 (1.13–2.24)**	1.22 (0.84–1.78)
6:00–11:59 pm		1	1	1
Road type				
Provincial highway		1	1	1
City/municipal road		1.45 (1.05–1.99)*	1.47 (1.07–2.03)*	1.20 (0.86–1.68)
Rural road		1.04 (0.60–1.80)	1.08 (0.62–1.89)	1.24 (0.59–2.57)

[a]Matching was completed on four crash-related variables: crash date, number of vehicles in the crash, time of the crash and road type.
*$P < 0.05$; **$P < 0.01$.

increased the odds of a culpable crash by 70%. This association was persistent across certain subgroups: male drivers, drivers aged between 26 and 65 years, drivers with a full license, drivers not suspected of using alcohol/drugs and for injury and non-injury crashes. These findings lend support to the limited body of epidemiological evidence showing that cell phone use while driving increases crash risk.[21,23,24]

Age exhibited distinct effects on the relationship between cell phone use and crash culpability, whereby cell phone use increased the likelihood of a culpable crash only for middle-aged drivers (26–65 years of age). Although driver's age has been included in studies of cell phone use and crash risk, it has been modelled, typically, as a control measure,[9,21,28,30] with limited analysis of age-specific effects. However, Redelmeier and Tibshirani's study,[23] carried out in the early 1990s when cellular phones were less prevalent, found consistently elevated crash risk across four age groups, with higher relative risks for younger age groups. McEvoy *et al*.[24] similarly found increased crash risk for those younger and older than 30 years of age. Our findings are not consistent with these studies. For young drivers in our study, those aged <26 years, the baseline risk of a culpable crash is already extremely high, and thus, the relative increase in the odds of a culpable crash from use of a cell phone was non-significant. Alternatively, as noted in a recent meta-analysis,[13] age is a significant moderator in the association between cell phone use and driving performance, such that young drivers were less affected by cell phone tasks than older drivers, in terms of reaction time and cognitive deficits.



	Male (*n*=715)	Female (*n*=376)	Age 16-20 (*n*=208)	Age 21-25 (*n*=193)	Age 26-40 (*n*=379)	Age 41-65 (*n*=268)	Age 66+ (*n*=41)	GDL (*n*=276)	Non GDL (*n*=815)	Impaired (*n*=193)	Not Impaired (*n*=898)	Injury crash (*n*=477)	Non Injury crash (*n*=614)
◆ Odds ratio	2	1.5	0.62	1.51	3.1	2.63	0.8	1.04	2.19	0.7	1.92	1.68	1.61
Upper CI	3.16	2.67	1.32	3.72	6.5	4.96	4.29	1.92	3.36	2.13	2.76	2.9	2.57
Lower CI	1.26	0.85	0.3	0.61	1.47	1.39	0.15	0.56	1.43	0.23	1.34	1	1.01

Figure 1 Cell phone-related crash culpability across population subgroups (unadjusted ORs and 95% CI)

Three limitations should be noted. First, it may be argued that non-culpable drivers were still involved in a crash and remain different from a true crash-free driver population. However, as noted above, the use of a harsh culpability scoring tool helps ensure that non-culpable drivers identified in our study approximate a random selection of crash-free drivers on the road at the time of the crash. Second, errors of human judgment are possible in the completion of the police reports used in the assessment of culpability; thus, subjectivity is not completely absent in determining driver responsibility. Our culpability assessment is dependent on the quality of data collection by police. Subjectivity has been minimized with respect to culpability assessment by the researcher. Third, the potential for misclassification bias is present in at least three respects. Cell phone use in crashes is assuredly under-reported by drivers and under-recorded by police. This is most problematic in defining the unexposed drivers, whereby some unexposed drivers had used a cell phone during their crash. Misclassification would result in an underestimate of the true effect of cell phones on crash culpability. Relatedly, the proportion of cell phone (16%) and non-cell phone (22%) crashes that occurred in poor weather conditions differed. If drivers tend to use cell phones in good weather, then we may have over-estimated the effect of cell phones on crash culpability. Finally, it is also possible that police may be more consistent in reporting cell phone use among drivers who are subsequently deemed culpable. As such, our estimates of the association of cell phone use with crash risk may be smaller or larger than the real effect.

Despite varying research designs and diverse measures of cell phone use,[21–28,30] the observational epidemiological literature has consistently reported elevated crash rates in conjunction with pre-crash cell phone use; further research is needed to examine the distinct crash risk associated with hands-free and hand-held cell phone use. A concurrent task is to increase driver compliance in those jurisdictions that already have a ban in place,[1,9,44] which can only be achieved by marrying comprehensive evidence-based legislation with effective enforcement to deter drivers[2] and evaluating the effectiveness of those bans in reducing cell phone-related crashes.

Supplementary Data

Supplementary Data are available at *IJE* online.

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Conflict of interest: None declared.

KEY MESSAGES

- The association between the use of cell phones while driving and crash culpability was examined.
- Overall, cell phone use was associated with culpable crash risk. This association was consistent for male drivers, for drivers aged between 26 and 65 years, for injury and non-injury crashes, for non-impaired drivers and for drivers with a full licence. There was no evidence of an association for younger (aged ⩽25 years) and older (aged 66–80 years) drivers, and those in a graduated licensing programme.
- Further research should explore whether this association persists for the use of hands-free vs hand-held devices, as well as examine the effectiveness of existing policies restricting cell phone use while driving.

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Commentary: Culpability analysis won't help us understand crash risk due to cell phones

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Global road traffic fatalities are expected to become the fifth leading cause of death in just a couple of decades.[1] In order to save lives, there is an urgent need to identify key risk factors and devote resources to high impact interventions. Among the efforts, there has been serious focus on the effects of distracted driving, and in particular, on the impacts of mobile phone usage.[2] Meta-analyses of large numbers of studies suggest driver performance is reduced by the use of cell phones.[3,4] However, there are relatively few studies that have investigated the relationship between cell phone use and crash risk. A recent review summarized these studies and estimated that crash risk increased by almost 3-fold due to cell phone usage,[5] but warned there were potentially serious weaknesses in all of the studies. Thus, the causal relationship between cell phone use and crash risk remains uncertain. In this issue of *IJE*, an article by Asbridge *et al*. aims to investigate this question through the use of a crash culpability analysis.[6]

The primary goal of the article by Asbridge *et al*., as stated in the opening of the discussion, is to 'assess the impact of cell phone use on crash risk in a naturalistic driving setting'. Using crash data from the Traffic Accident System in British Columbia, it starts by identifying drivers who were noted to be using a cell phone by police, and uses propensity scores to match these with unexposed persons. The article estimates the outcome, culpability, using a tool that considers seven categories of the crash event, including weather, road type and unsafe driving actions. Though the term 'culpability' is used in the article,