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The driver-level crash risk associated with daily cellphone use and cellphone use while driving

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ABSTRACT

This study examined the overall prevalence of cellphone use, including the rates of calls and texts both per day and hourly while driving, and assessed whether or not individual crash risk was correlated with cellphone use. The study used data from the Second Strategic Highway Research Program Naturalistic Driving Study (SHRP 2 NDS), which had more than 3500 participants who provided up to three years of driving data. Of these participants, 620 provided cellphone records, 564 of which included both call and text records. The prevalence of cellphone calls and texts per day was calculated. By overlaying the cellphone records with the SHRP 2 NDS data, we also evaluated the rates of calls and texts while driving by driver demographics. Crashes for these cellphone-using participants were also identified from the SHRP 2 NDS data. Negative binomial regression models were used to determine whether the crash rate was associated with cellphone use. Participants made an average of 27.1 texts and 7.3 calls per day. They averaged 1.6 texts and 1.2 calls per hour of driving. Cellphone use varied significantly by age, especially for texting. The texting rate for drivers aged 16–19 was 59.4 per day and 2.9 per hour of driving, four times higher than the 14.3 per day and 1.0 per hour for drivers 30–64 years old. The texting rate for drivers 20–29 years old was also high at 42.4 per day and 2.6 per hour of driving. Participants experienced 243 crashes in 216,231 h of driving. It was found that those who texted more often per day or per hour of driving had higher crash rates after adjusting for age and gender effects. The severe crash rate increases 0.58% for every additional text per day and all 8.3% for every text per hour of driving; overall crash rate increases 0.41% for every additional text per day and 6.46% for every text per hour of driving. The results show that cellphone texting and calling are quite common while driving. The texting rate for young drivers is substantially higher than for middle-aged and senior drivers. This study confirmed that those who text at a higher rate are associated with a higher crash risk.

1. Introduction

Cellphones have become ubiquitous in America in recent years, with an estimated 92% of American adults owning a cellphone in 2015, up from about 65% in 2004 (Anderson, 2015; Rainie and Zickuhr, 2015; Smith, 2015). Though these estimated percentages were equal between males and females, a higher percentage of younger people were estimated to own cellphones. In 2015, an estimated 98% of people aged 18–29 and an estimated 96% of those aged 30–49 owned cellphones. For the same year, among the 50–64 age group and those aged 65+, ownership dropped to an estimated 90% and 78%, respectively (Anderson, 2015).

In light of the prevalence of cellphone use while driving, there is ongoing interest in the possible effects of cellphones on crash risk. The risk of a crash while driving in the United States continues to be pervasive. Recent statistics from the National Highway Traffic Safety Administration, 2017) indicate that more than 35,000 people were killed and more than 2.2 million injured in crashes in 2015. Although there has been a general downward trend in the rate of fatalities/injuries over the last 25 years, that trend may have plateaued over the last seven years, or even reversed recently (National Highway Traffic Safety Administration, 2017). Human error could be a contributing factor in more than 90% of the crashes (National Highway Traffic Safety Administration, 2017).

Previous studies show that drivers may see an increased safety risk, such as increased crashes/near-crash risk, while using a cellphone (Asbridge et al., 2013; Caird et al., 2014; Dingus et al., 2016; Farmer et al., 2015; Fitch et al., 2013; Guo et al., 2017; Guo et al., 2010; Klauer

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et al., 2006, 2014; Redelmeier and Tibshirani, 1997; McEvoy et al., 2005; Olson et al., 2009; Victor et al., 2015). This is unsurprising in light of the fact that recent research has found that crash risk increases considerably with distraction. For example, Dingus et al. (2016) estimated that about 36% of all crashes could be avoided if no distraction was present. Cellphone use may lead to visual-manual distraction, requiring drivers to take their eyes off the road for some period of time, and cognitive distraction, requiring drivers to focus part of their mental attention on a cognitive task separate from the driving task. Tasks associated with cellphone use that may involve visual-manual or cognitive distraction include dialing, talking, texting, reaching for the phone, or browsing on the phone. Dingus et al. (2016) found that all of the activities above increased crash risk; Guo et al. (2017) showed that cellphone use while driving poses a higher risk for younger drivers compared to middle-aged drivers. Certain cellphone tasks, such as texting, might lead to both visual-manual and cognitive distraction, and impose a higher risk.

However, whether drivers who have high cellphone use rates are generally at higher risk of crashing while driving compared to drivers with lower rates of cellphone use remains largely unknown. Many studies have focused on instances of driving and the probability of a crash given cellphone use/secondary task, as opposed to investigating whether drivers who use cellphones more often overall experience more crashes (Dingus et al., 2016; Guo et al., 2017; Klauer et al., 2014; Guo et al., 2018). A few studies evaluate driving risk at driver level (Guo and Fang, 2013; Guo et al., 2013, 2015). Though any relationship between overall cellphone use and crash risk may be explained partially by a correlation between overall cellphone use and cellphone use while driving, an association may also be indirect, where more-frequent cell phone users tend to perform other risky behaviors more often than less-frequent cell phone users. Beck et al. (2007) found that drivers who reported using cell phones while driving were more likely to perform risky driving behaviors such speeding and drowsy driving. Zhoa et al. (2013) found that those who reported using cell phones more frequently while driving had a higher risk of faster driving and increased frequency of hard braking/acceleration.

Some recent research has attempted to investigate overall driver cellphone use and its relation to crash risk. Using self-reported data, Laberge-Nadeau et al. (2003) found that specific months with heavy cellphone call levels in Canada (i.e., more than 259 calls per month for men and more than 115 calls per month for women) were associated with 2–3 times greater risk of having at least one crash compared to months with the lowest numbers of calls (i.e., less than 14 per month for men and less than 20 per month for women). Farmer et al. (2015) used the 100-Car Naturalistic Driving Study (NDS) data to evaluate the relationship between cellphone use and crash/near-crash risk based on video reduction data, though total time using a cellphone while driving could only be estimated by video reduction on a sample of participant driving trips. Although Farmer et al. (2015) found an increased likelihood of a crash or near-crash when someone was using a cellphone while driving, they did not find a significant relationship between a person's total time using cellphones while driving and their total risk of a crash or near-crash.

The current study was conducted with the aim of characterizing the total amount of cellphone exposure between different demographic groups and examining the association between cellphone exposure and crash risk. The Second Strategic Highway Research Program Naturalistic Driving Study (SHRP 2 NDS) was used to gather driving and cellphone use information from more than 600 drivers from 2010 to 2013 (Cook et al., 2015; Hankey et al., 2016). Access to cellphone records allowed a more objective measurement of cellphone use than merely relying on participants' self-reported memories. Using SHRP 2 NDS participants' cellphone records (voluntarily provided) from their time in the study, a picture of cellphone use was thus developed for each participant.

This study also aimed to assess drivers' risks of crashing as it related to their overall use of cellphones. Among the more than 600 SHRP 2 NDS participants included in this study, 243 crashes were observed, providing more power to detect differences in crash risk than previous studies. The use of the SHRP 2 NDS data also allowed for the precise calculation of driving mileage for participants, enabling precise accounting for driving exposure when estimating crash risk as a function of cellphone use. Due to the precision in measurement of total crashes and total cellphone exposure, this study offers a robust examination of whether drivers with high rates of cellphones use have higher crash rates.

2. Materials and methods

2.1. Participants

The SHRP 2 NDS recruited more than 3500 drivers from six regions in the United States (Hankey et al., 2016; Antin et al., 2015). The six study sites used were Buffalo, New York; Seattle, Washington; Tampa, Florida; Durham, North Carolina; Bloomington, Indiana; and State College, Pennsylvania. At these six sites, project personnel used a variety of recruitment techniques, including (but not limited to) flyers, social media, newspapers, and television advertisements. Participants were compensated at $300–$500 per year, depending on when they were first recruited (Dingus et al., 2015). To support the investigation of cellphone use, 620 of these participants volunteered to provide their cellphone records for the time in which they participated in the SHRP 2 NDS. Of these participants, two were excluded due to insufficient driving data, and 54 were excluded due to an absence of texting data (all participants had call data).

The SHRP 2 NDS oversampled participants in younger age groups (16–19 and 20–24) and older age groups (75–79, 80–84, and 85–89) (Antin et al., 2015) as both of these general age groups have higher crash risks (Stutts et al., 2009). Participants represented 15 age groups. To preserve sufficient sample sizes in each age stratum, these 15 groups were aggregated to four groups: 16–19, 20–29, 30–65, and 65 + . Breakdowns of the study sample by age and gender are provided in Table 1. Note that for six of these participants, the age group and site are unknown (one failed to specify their gender). Therefore, these participants were not used in the final analysis. Additionally, one driver did not have driving that overlapped with available cell phone records, and so text and call rates per hour of driving could not be calculated. This participant was also removed from the final analysis. Thus, there were 557 participants used to generate the final results in this study. There were 137 participants (24.6%) from the Washington site, 136 (24.4%) from the New York site, 122 (21.9%) from the Florida site, 86 (15.4%) from the North Carolina site, 64 (11.5%) from the Pennsylvania site, and 12 (2.2%) from the Indiana site.

Besides age and gender, other demographic factors could potentially affect crash risk such as income level. Caution should be used when generalizing the conclusions of this study to the general population. The Transportation Research Board has published a detailed comparison of SHRP 2 NDS study population and the national general driver population (Antin et al., 2015).

Table 1
Participant Age and Gender Group Distribution.

Age Group	N	Percentage	Female Frequency	Male Frequency
16–19	78	14.0%	47	31
20–29	183	32.9%	105	78
30–64	175	31.4%	94	81
65 +	121	21.7%	52	69
Total	557	100%	298	259