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Predicting cellphone manipulation based on magnitude of speeding

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ABSTRACT

Objective: The current study was conducted to assess the relationship between speeding behavior and handheld cellphone manipulation on different roadway classes.

Methods: Cambridge Mobile Telematics provided a dataset of trips in the United States made by drivers who used its smartphone-based platform from July through October 2024. The final sample comprised 35,000–40,000 trips per U.S. Census region each month (N = 593,454 trips). We used negative binomial regression models to predict the cellphone manipulation rate based on the speed limit and an indicator for how fast the vehicle was traveling relative to that limit during free-flow travel. An interaction term between speed limit and speeding behavior was included with covariates for time of day, day type, and area type. Models for limited-access and primary/collector roads were estimated separately due to little overlap in speed limits.

Results: A 5 mph increase in speed relative to the limit was associated with an increase in cellphone manipulation, although the magnitude of this increase was nearly 4 times as great on limited-access roads as on primary/collector roads. Statistically significant interactions between speeding and speed limit showed that the relationship between speeding magnitude and cellphone manipulation rates was exacerbated on both road types when the speed limit was higher.

Conclusions: Both the reduced complexity of higher speed roads and the tendency for some drivers to take multiple risks likely help explain why speeding and cellphone manipulation occur together. These findings could aid traffic law enforcement in identifying locations where enforcing speeding and handheld cellphone laws together would be most effective. Countermeasures that raise perceived roadway complexity may also reduce the likelihood of both phone manipulation and speeding.

Keywords: Cellphone manipulation, speeding, distraction, telematics

INTRODUCTION

Distraction and speeding cause crashes for different reasons. Visual-manual distraction raises the odds of missing critical events that can lead to collisions (Klauer et al. 2006; Kidd and McCartt, 2015; Dingus et al. 2016), and speeding reduces the margin of error and compounds crash forces (Elvik et al. 2019). It follows, therefore, that the two behaviors likely represent a greater risk when they are combined than either behavior does separately, but their co-occurrence is largely unstudied.

Prior work indicates that drivers adjust behavior based on the perceived risks of a distraction (e.g., visual, voice, cellphones, grooming) and situational factors (e.g., traffic and environmental conditions). Drivers are more likely, for example, to engage in distraction while traveling at lower speeds or in simpler traffic settings (straightaways, on divided roads) than while traveling at higher speeds or in more complex scenarios (roundabouts, on undivided roads) (Kidd and Chaudhary, 2019; Ismaeel et al. 2020; Seaman et al. 2022; Cuentas-Henandez et al. 2023). Yet roadway environments have countless features, some of which may increase risk and others that may decrease it. Limited-access roads, for instance, have the highest speed limits but separate traffic streams, which greatly reduce head-on and T-bone collisions. How these elements combine to affect a driver's perception of risk remains unclear.

Limited evidence suggests that there is a positive correlation between distraction and speeding among certain drivers. A small-scale field study by Zhao et al. (2013) found that drivers who self-reported high levels of prior cellphone use drove faster and spent more time in passing lanes compared with drivers who reported less cellphone use. Zhao et al. did not explore speeding behavior specifically, however. The co-occurrence of risky driving behaviors may be largely driven by a driver's propensity to take risks, with multiple risky behaviors commonly factoring into a given fatal crash. For example, a much larger proportion of drivers in fatal collisions who were speeding also had blood alcohol levels of at least 0.08 g/dL relative to drivers who were not speeding (National Center for Statistics and Analysis [NCSA], 2025b). Indeed, Lerner et al. (2008) found that self-reported willingness to engage in a host of hypothetical distractions was largely informed by driver motivations and driving style and was insensitive to environmental attributes. In sum, research suggests that individual differences in risk perception are a key indicator for the decision to engage in distraction while driving.

The current study used telematics data to identify whether cellphone manipulation and speeding over legal limits covary and if any relationships are moderated by speed limit or road functional class. Prior work, such as roadside observational studies conducted by the National Highway Traffic Safety Administration (NHTSA), provide accurate insight about speeding (De Leonardis et al. 2018) and cellphone use (NCSA, 2024) in real road conditions at a national level, but each excludes the other behavior. These representative datasets, while valuable, are also limited in that they provide snapshots of instances in time regarding longitudinal phenomena. Roadside observational studies of cellphone use also typically exclude high-speed roads. Naturalistic driving studies, such as the Strategic Highway Research Program (SHRP2), are the gold standard for studying full trips but are based on small samples of drivers and also have the technical challenge of identifying speeding behavior. For example, SHRP2, the largest naturalistic driving study of U.S. drivers to date (Hankey et al. 2016), did not have speed limit information for most mileage, so speeding was largely unavailable and the study is dated. On-road experiments that have better ecological validity than self-report or simulator research are similarly limited in scope and sample size and, additionally, often must use low-risk secondary tasks to limit danger to participants.

Telematics, or wireless transmission of data, has ballooned in the United States from usage-based auto insurance that prices premiums at an individual driver level using driving history measured from sensors now primarily housed in smartphones. Its real-time sampling of vehicle speed, driver cellphone behavior, and location provided a unique opportunity to study this underexplored relationship between speeding and cellphone distraction. The key contribution of our approach was related to the availability of a dataset based on nearly 600,000 full trips completed by drivers distributed across 46 states during which speeding magnitude, cellphone use, and location data were available from the start to finish of each trip. The official numbers published by NHTSA on distraction-related crashes in the United States every year—8% of fatal and 13% of all police-reported crashes in the United States in 2023—are presented with the caveat that the numbers are likely underestimates due to limitations of crash investigation (NCSA), 2025a). The report presents an implausibly low number of deaths in crashes involving a driver who used a cellphone in 2023 (*N* = 397 or < 1% of all traffic deaths). The co-occurrence of speeding and distraction might also contribute to the underreporting of distraction, as investigators may fail to explore the possibility of cellphone use after determining that speeding contributed to a crash.

The current project was a collaboration with Cambridge Mobile Telematics (CMT). CMT developed the telematics platform that many insurance providers currently use for their usage-based policies to sense and record data from millions of trips per day throughout the United States. We explored relationships between speeding and cellphone distraction using several hundred thousand trips made between July and October 2024 from the four regions of the country defined by the U.S. Census Bureau. Specifically, we estimated whether the magnitude of speeding relative to the limit influenced the probability of cellphone manipulation on both limited-access roads and primary/collector roads. We focused on manipulation because it is associated with higher crash risk (e.g., Dingus et al. 2016) and there is evidence that it is more sensitive to changes in roadway complexity than other cellphone behaviors (Kidd and Chaudhary, 2019).

METHODS

Sampling

Data for this study came from drivers using CMT's platform who completed trips in states throughout the U.S. (excluding Alaska, California, Hawaii, and New York) from July 1 through October 31, 2024. CMT provided anonymized data that included location, time, speed, and driver phone use. We selected users who downloaded the software on their smartphones for passenger vehicle insurance purposes. Post-processing efforts were undertaken by CMT to ensure that data came from drivers in passenger vehicles (i.e., not on a bus, airplane, or bicycle). CMT also allows customers to label trips as "driver's phone used by passenger," or to reclassify trips from driver to passenger, making it possible to exclude these data from the analysis as well.

The goal of our sampling methodology was to create a minimum dataset of 160,000 trips comprising at least 10,000 randomly selected trips per region-month that met three sampling requirements. One requirement was a minimum trip duration of 18 minutes, which was chosen based on the average person trip length (12.6 miles) reported by U.S. households in 2022 (Federal Highway Administration, 2024). We also required trips to have at least 2 minutes of travel on an interstate, ensuring that selected trips would include some exposure on limited-access and other roads. We also limited sampling the same driver repeatedly so that no driver had more than two trips in a region, and no driver had more than one trip in any region-month. Because these requirements introduced uncertainty about meeting the sampling goal, additional trips were sampled to reach the final dataset of 593,454 trips. Final trip counts for each region-month were relatively similar, ranging from 35,721 (South, July) to 38,470 (Midwest, September).

Data

The dataset used for our analyses contained values for total travel time stratified by region (Midwest, Northeast, South, West), month, area (rural, urban), speed limit of the road, and relative speed of the vehicle (i.e., the difference between the vehicle speed and the limit, grouped in 5 mph increments and grand mean-centered). We also stratified by day vs. night (6:00 a.m.–8:59 a.m. vs. 9:00 p.m.–5:59 a.m.) and by weekdays vs. weekends (6:00 a.m. Monday–8:59 p.m. Friday vs. 9:00 p.m. Friday–5:59 a.m. Monday). Each total driving time value was accompanied by a total handheld phone manipulation time value, and manipulation time was divided by driving time to estimate the rate of handheld phone manipulation.

CMT identifies speed limits and road classes by GPS coordinates map-matched to the Open Street Map (OSM) road network. OSM speed limit codes may be inaccurate or missing in cases of unsigned roads or changed limits, and speed limits were missing most often on residential roads. To maximize speed limit accuracy, we restricted our analysis to travel that occurred on the four highest OSM road types (i.e., motorway, trunk, primary, and collector roads). We defined OSM's two highest road class codes as limited access and only analyzed limited-access driving when speed limits were 55 mph or higher. We also combined OSM codes of primary or collector roads and analyzed speed limits of 55 mph or lower on these. Every road segment was also classified as urban or rural based on the Census definitions from 2024.

Levels of speeding relative to the speed limit were grouped according to 5 mph increments, and we limited analyses to five levels of speeding: 0 to 5 mph under (i.e., not speeding), > 0 to 5 mph over, > 5 to 10 mph over, > 10 to 15 mph over, and more than 15 mph over the limit. We did not analyze speeds slower than 5 mph below the limit to focus on free-flow traffic conditions. This strategy, proposed by Richard et al. (2020), infers that free-flow conditions present drivers an opportunity to speed and therefore that drivers traveling more than 5 mph under the limit are likely impeded by upstream traffic.

Handheld phone manipulation was identified with CMT's cellphone motion measure, which detected when the phone rotated significantly based upon the gyroscope while the screen was unlocked. The movement indicates the driver is handling the phone with an unlocked screen in a pattern that suggests cellphone manipulation, but it does not identify or track use of particular software applications so that manipulating the phone to text, search for a song, or take a photo were not differentiated. This measure also does not capture phone calls, voice-based interactions, or other forms of distraction.

Analysis plan

The amount of distracted driving time was estimated using negative binomial regression models. This approach was motivated by the structure of the data: distracted driving time exhibited a highly right-skewed distribution, with variance exceeding the mean. Negative binomial regression was well suited for modeling data with these properties. By default, negative binomial models estimate a single dispersion parameter for all observations. However, variability in distracted driving time may differ across roadway speed environments. To accommodate this possibility, we modeled separate dispersion parameters for each speed limit category, allowing the degree of overdispersion to vary by roadway context. Finally, the natural logarithm of total driving time was included as an offset term, which allowed us to express the outcome as a rate rather than as a raw duration.

We collapsed driving across the following speed limits: 25–30 mph, 35–40 mph, 45–50 mph, 60–65 mph, and any limit 70 mph or higher. We predicted distraction rate with speed limit and a grand mean-centered indicator for how fast the vehicle was traveling relative to the speed limit (−5 to 0 mph, > 0 to 5 mph, > 5 to 10 mph, > 10 to 15 mph, or > 15 mph). An interaction term between speed limit and speeding behavior was also included in the model. Covariates included time of day (day vs. night), day type (weekday vs. weekend), region (West, Midwest, Northeast, South), and area type (rural vs. urban). Separate models were estimated for limited-access roads and primary/collector roads given that the speed limits on these road types had little overlap. Collinearity diagnostics were examined and did not indicate meaningful multicollinearity among the non-interaction covariates.

RESULTS

Limited-access roads

Drivers in our sample drove faster than the limit during 80% of free-flow driving time while on limited-access roads; drivers manipulated cellphones in 1.8% of this free-flow driving time, on average. We observed a positive relationship between speeding behavior and handheld cellphone manipulation for drivers traveling along limited-access roads. On average, every 5 mph increase in speed relative to the limit was associated with a 12% increase in the rate of cellphone manipulation, 95% confidence interval (CI) [9.8%, 14%], $p < .001$. There were also differences in drivers' tendency to use their phones by speed limit. Compared with 55 mph roads, the handheld cellphone manipulation rate was 9% higher on 60–65 mph roads ($p = .002$) and 11% higher on those with speed limits greater than 70 mph ($p = .024$). More cellphone manipulation was observed in urban environments compared with rural ones (+10%, $p < .001$), but there were no meaningful effects for the other environmental covariates (night/day and weekend/weekday). Full regression estimates can be seen in Table 1.

The strength of the relationship between speeding behavior and handheld cellphone manipulation differed by speed limit (i.e., a significant interaction). For each additional 5 mph that drivers traveled relative to the speed limit, the rate of cellphone manipulation increased 5% more on 60–65 mph roads ($p = .004$) and 9% more on 70+ mph roads ($p = .004$) than it did on 55 mph roads. That is, the faster that drivers traveled, the stronger the link between speeding and handheld cellphone manipulation, especially as the speed limit of the road increased (Figure 1).

Table 1

Negative binomial regression estimates predicting handheld phone manipulation on limited-access roads

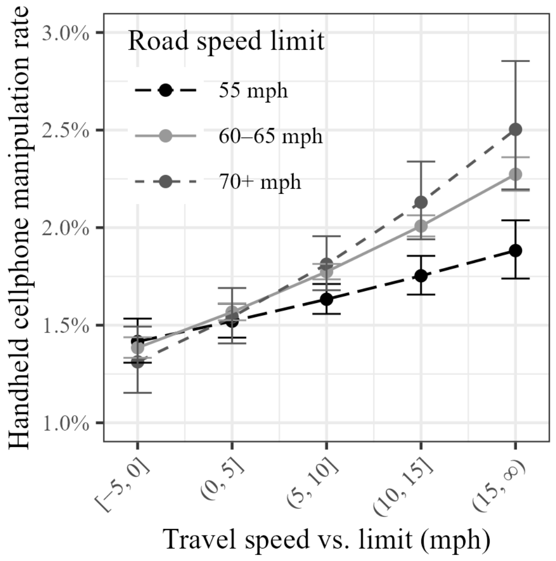
	IRR	95% CI	*p*	
Night/day	1.00	[0.96, 1.04]	.994	
Weekend/weekday	0.97	[0.94, 1.01]	.177	
Midwest/West	1.07	[1.01, 1.13]	.015	*
Northeast/West	1.12	[1.06, 1.18]	<.001	***
South/West	1.23	[1.17, 1.30]	<.001	***
Urban/rural	1.10	[1.06, 1.14]	<.001	***
60–65/55 mph	1.09	[1.03, 1.14]	.002	**
≥ 70/55 mph	1.11	[1.01, 1.21]	.024	*
Degree of speeding	1.07	[1.04, 1.11]	<.001	***
60–65/55 mph × Degree of speeding	1.05	[1.02, 1.09]	.004	**
≥70/55 mph × Degree of speeding	1.09	[1.03, 1.16]	.004	**

Note. Incidence rate ratios (IRRs) are shown with 95% confidence intervals (CI). Each predictor is expressed relative to its reference category, indicated after the slash.

*** = $p < 0.001$, ** = $p < 0.01$, * = $p < 0.05$.

Figure 1

Handheld phone manipulation rates on limited-access roads by speeding behavior and speed limit



Primary and collector roads

Drivers in our sample drove faster than the limit during 66% of free-flow driving time while on primary and collector roads; drivers manipulated cellphones in 1.9% of this free-flow driving time, on average. The relationship between speeding behavior and handheld cellphone manipulation for drivers traveling along primary and collector roads was somewhat different than it was for those traveling along limited-access roads. Overall, an increase of 5 mph was associated with a comparatively modest 3.4% more handheld cellphone manipulation, 95% CI [2.7%, 4.1%], $p < .001$. However, we observed a somewhat inverse relationship between speed limit and cellphone manipulation along primary and collector roads—the reverse of what was observed for limited-access roads—such that the lowest speed limit bin was associated with the highest rate of handheld cellphone manipulation overall. Compared with the rate along the slowest roads (25–30 mph), we observed 6% less cellphone manipulation along 35–40 mph roads ($p < .001$), 10% less along 45–50 mph roads ($p < .001$), and 5% less along 55 mph roads ($p = .007$). Environmental factors also had a slightly greater effect on driver behavior along primary and collector roads than they did along limited-access roads, with 21% more handheld cellphone manipulation in urban areas than in rural ones ($p < .001$) but also 6% less handheld cellphone manipulation observed on weekends than on weekdays ($p < .001$). There were again no meaningful differences by time of day. Full regression estimates are shown in Table 2.

The relationship between speeding behavior and handheld cellphone manipulation again differed by speed limit. Primary and collector roads with the slowest speed limits (25–30 mph) saw only a negligible increase in the cellphone manipulation rate as the degree of speeding increased (just 1% more for each 5 mph increase). On roads with higher limits, drivers manifested a stronger relationship between speeding and cellphone manipulation: compared with the effect on 25–30 mph roads, we observed an effect that was 1% stronger on 35–40 mph roads, 3% stronger on 45–50 mph roads, and 7% stronger on 55 mph roads (although only the latter two were statistically significant, *ps* < .05). It is notable that the relationship between speeding and distraction for 55 mph roads was so much stronger than the rest, with handheld cellphone manipulation increasing by 36% from the slowest speeding category (−5 to 0 mph: 1.6%) to the highest (≥15 mph: 2.2%; Figure 2). Interestingly, the increase in handheld cellphone manipulation with greater speeding along 55 mph roads was similar across both road types, with distraction rates on limited-access roads increasing by a comparable 33% from the lowest to highest speeding categories (−5 to 0 mph: 1.4% and ≥15 mph: 1.9%).

Table 2

Negative binomial regression estimates predicting handheld phone manipulation on primary and collector roads

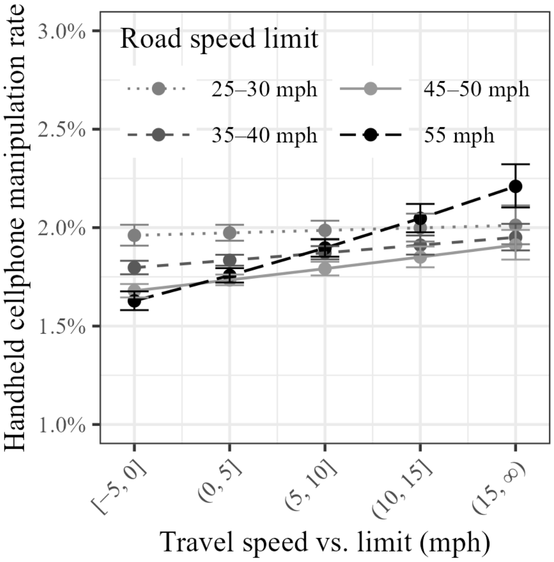
	IRR	95% CI	*p*	
Night/day	1.00	[0.98, 1.02]	.905	
Weekend/weekday	0.94	[0.93, 0.96]	< .001	***
Midwest/west	1.04	[1.02, 1.06]	< .001	***
Northeast/west	1.05	[1.03, 1.07]	< .001	***
South/west	1.30	[1.28, 1.33]	< .001	***
Urban/rural	1.21	[1.19, 1.24]	<.001	***
35–40/25–30 mph	0.94	[0.92, 0.97]	< .001	***
45–50/25–30 mph	0.90	[0.88, 0.93]	< .001	***
55/25–30 mph	0.95	[0.92, 0.99]	.007	**
Degree of speeding	1.01	[0.99, 1.02]	.418	
35–40/25–30 mph × Degree of speeding	1.01	[1.00, 1.03]	.143	
45–50/25–30 mph × Degree of speeding	1.03	[1.01, 1.05]	.010	*
55/25–30 mph × Degree of speeding	1.07	[1.05, 1.10]	< .001	***

Note. Incidence rate ratios (IRRs) are shown with 95% confidence intervals (CI). Each predictor is expressed relative to its reference category, indicated after the slash.

*** = $p < 0.001$, ** = $p < 0.01$, * = $p < 0.05$.

Figure 2

Handheld phone manipulation rates on primary and collector roads by speeding behavior and speed limit



DISCUSSION

The current study found a strong positive relationship between handheld cellphone manipulation and speeding behavior. This relationship is alarming because (1) the increases were largest on the highest speed limit roads and (2) this relationship held on limited-access and primary and collector roads. Our findings are consistent with Zhao et al. (2013), who showed that drivers who reported frequent phone manipulation engaged in speeding behaviors more often than drivers who reported less phone manipulation. Our results are somewhat counter, however, to those of Seaman et al. (2022) and Kidd and Chaudhary (2019), who reported that drivers limit phone manipulation to lower speeds, although these studies included low-speed and stopped-traffic conditions that we excluded. We also found that rising speed limits only elicited more handheld phone manipulation on limited-access roads, whereas on primary and collector roads the lowest limits had the highest rates of phone manipulation. This difference points to the influential role that environmental factors can have on driver behavior. The higher probability of phone manipulation in urban areas than in rural areas also supports such an interpretation. Thus, handheld phone manipulation seems to be subject to dual driver and environmental pressures.

The reduced likelihood of phone manipulation at higher speed limits on primary and collector roads may reflect differences in risk perception. Limited-access roads are designed for high-speed, uninterrupted travel, whereas drivers on primary and collector roads confront frequent intersections, driveways, vulnerable road users, and traffic control devices (Federal Highway Administration, 2023). The presence of these features may discourage secondary task behaviors at higher speeds by placing greater demands on attention. Higher limits on interstates or freeways within a jurisdiction may be dictated by proximity to rural or urban areas, and speed limit increases on such roads may be strongly related to reduced congestion and access points that present motivated drivers opportunities to speed and use their phone unique to these roads. However, more research is needed to fully separate the variability in cellphone use and speeding associated with the situation (weather, traffic flow), road environment (roadway design, presence of vulnerable road users, opportunity to speed) and individual differences in risk taking.

Future work that leverages more precise data about the driving environment will help clarify the mechanisms of drivers' willingness to engage in secondary tasks. For example, changes to speed limits occur for several reasons, including rural-urban proximity, the presence of vertical or horizontal curves, or changing lane or shoulder width (Federal Highway Association, 2025). Drivers may speed because they are running late, seeking a thrill, traveling with a platoon of speeding vehicles, or taking a long trip (Richard et al. 2012; Payyanadan et al. 2024). Although we limited our analyses to free-flow driving in an effort to exclude times when drivers lacked the opportunity to speed, this approach is not perfect. Having more information on roadway design, traffic flow, or factors related to driver motivations would further help disentangle drivers who want to speed but cannot from those who are not speeding because they feel unsafe. Opportunity to engage in cellphone manipulation is less constrained by such external factors, but information related to variables such as the presence of passengers or driver age could also help future research disentangle the interplay of environmental and driver-related factors on the co-occurrence of speeding and distraction (Goodwin et al. 2012; Guo et al, 2017).

In addition to basic problem identification, our results illustrate the utility of telematics to inform countermeasure deployment decisions in a time of constricted resources. Special traffic enforcement campaigns typically focus on a single behavior (e.g., *Click It Or Ticket)*, although there are exceptions (e.g., seat belt use and impaired driving). Our findings suggest that combined efforts to reduce speeding and cellphone law violations may be an efficient way to create a general deterrent among the broader community that is intended with high-visibility traffic enforcement. The stronger relationship between speeding and driver distraction on faster roads suggests that such dual efforts might be most useful if targeted at areas with higher speed limits, especially along limited-access roads. Common enforcement techniques for cellphone bans include having officers stand at junctures or patrol roadways in unmarked vans or buses to peer into vehicles for violations, techniques that may preclude enforcement on high-speed roads. Safety cameras have recently been deployed to accurately detect cellphone manipulation when vehicles are in motion (see Woods et al. 2023). Deploying safety cameras to enforce speeding and cellphone violations could address the challenges in higher speed environments. Roadway design changes, such as adding chicanes to a previously straight road, may slow drivers down and address cellphone use. Work like ours could identify locations on primary and collector roads where such changes would be most beneficial.

Strong relationships between the perceived likelihood of getting a ticket and driver compliance indicate the need to have police enforcing laws, and this is echoed by data from focus groups when drivers discuss situational factors that lead to violations (Richard et al. 2012). Hayashi et al. (2023) identified three types of individuals regarding propensity to manipulate phones when driving: those who do not do it while driving because they believe the behavior is risky, those who do it despite believing it is risky, and those who do it because they do not believe it is a risk. A similar approach for the propensity to speed suggests it is also a stable element of driver personality; drivers observed speeding one day will likely be seen speeding the next or when driving with or without adaptive cruise control (Richard et al. 2012; Monfort et al. 2022). External motivation in the form of incentives may be particularly effective for compelling change among drivers with a high likelihood of either behavior. Telematics programs that lower premiums when drivers avoid speeding or phone manipulation are associated with significant reductions in speeding and cellphone manipulation without controlling for levels of police enforcement (Ebert et al. 2025). With sustained high-visibility enforcement, incentive-based programs may become an appealing way for officials to reduce risky driving and crash rates.

The telematics data used for the current study are limited due to potential survivor bias, so the drivers may be safer than the average driver. To the extent that the drivers in our sample were on the safer side, then the relationship identified between speeding and cellphone manipulation may be even stronger than indicated in the current study. Prior work using a CMT dataset showed national patterns of driver distraction that paralleled nationally representative estimates of distraction measured by NHTSA (Reagan et al. 2024) suggesting the telematics measures provide reasonable measures of phone manipulation. The significant relationships between increased speeding magnitude and handheld phone manipulation observed in our study highlight another practical use of telematics for road safety.

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