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# Identifying factors related to a hit-and-run after a vehicle-bicycle collision

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## ABSTRACT

**Purpose:** Understanding bicycle-vehicle collisions that result in hit-and-run (HAR) behavior is an important concern for multiple disciplines, such as public health, transportation safety, enforcement, and affected individuals. If bicyclists are injured, this issue has implications for expedient access to medical care and for protection from the financial burden of associated injury and property costs. This study aimed to identify significant predictors of vehicle-bicycle HARs, the results of which help inform interdisciplinary prevention interventions.

**Method:** Data were collected from Boston Police Department bicycle collision reports for 2009–2012. The data identified whether a collision was a HAR and other predictor variables including road and bicyclist characteristics. The probability of a HAR was fit to selected variables through logistic regression models. Effects of the predictors were reported as odds ratios.

**Results:** Police reported data from Boston, Massachusetts were examined for the years 2009 to 2012. Of the 1646 bike-vehicle collisions, 6% (n=93) resulted in a HAR and 80% (n=1309) involved an injury to the bicyclist. Controlling for all other variables, the odds of a HAR did not differ when the bicyclist was injured versus not injured or male versus female. The odds of a HAR were 2.40 (95% CI: 1.31, 4.23) times more likely when the vehicle was a taxi versus another type of vehicle, 1.65 (95% CI: 1.08, 2.54) times more likely during night as during daylight hours, and 1.74 (95% CI: 1.07, 2.66) times more likely during the weekend versus during the week. The interactions of male-by-injured, taxi-by-injured, and night-by-weekend were nonsignificant.

**Conclusion:** The probability of a HAR partially depends on time, day of the week, and whether the vehicle type was a taxi. We discuss implications for policies and interventions aimed at preventing this type of collision and crime.

## 1. Introduction

The National Highway Traffic Safety Administration estimates that in the United States, 49,000 bicyclists were injured and 726 killed in 2012 as a result of a motor vehicle collision (National Highway Traffic Safety Administration, 2014a). In that same year, the City of Boston, Massachusetts, reported 493 bicycle collisions of which 489 bicyclists were injured and 4 were killed (City of Boston, 2013). Like vehicle-vs-vehicle (VvV) and vehicle-vs-pedestrian (VvP) collisions, some fraction of vehicle-vs-bicycle (VvB) collisions

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can be hit-and-runs (HAR). Little research exists on bicycle HARs. Bicycle crashes are relatively rare, making data about the actual incidence and predictors of HAR VvB collisions scarce. This study can contribute to the body of work done on HARs of the other modes. The aims of this study were to estimate the incidence of HARs among vehicle-bicycle collisions and to identify significant predictors of these incidents in an American urban setting, the results of which may inform interdisciplinary or interagency prevention interventions, such as education of road users, enforcement of traffic laws, and design of the built environment. Based on the literature on this topic, predictors of interest were the bicyclists' gender and their injuries as well as whether the involved vehicle was a taxi.

VvB crashes can result in poor health outcomes—ranging from physical to psychological. Bicyclists commonly sustain injuries to three body regions— the head, the face, and the chest (Chen et al., 2013). Among injured bicyclists, injuries to the head account for two thirds of admissions to the hospital (Cripton et al., 2014). Not surprisingly, crash survivors (i.e., motorists and bicyclists) experience psychological distress which, if left untreated, can result Post-Traumatic Stress Disorder (PTSD) and other mental health conditions (Guest et al., 2016). Heron-Delaney et al. (2013) found that the prevalence rates of PTSD among traffic crash survivors in the United States ranged from seven to 39% when measured four to 12-months after the crash. This was independent of the severity of the injury. Furthermore, the process of litigation and compensation can contribute to PTSD among survivors (Heron-Delaney et al., 2013).

Bicyclists are vulnerable road users compared to those driving or occupying a vehicle (World Health Organization, 2013). When a collision happens, a significant probability exists that the bicyclist will sustain an injury, while the likelihood is small that the vehicle occupants will be injured (Haworth and Debnath, 2013). Bicyclists are most at risk for poor mental health outcomes after a crash compared to motorists and motorcyclists (Papadakaki et al., 2017). The cost of medical care for treating injured bicyclists involved in VvB collisions tends to be higher than for treating the injured vehicle occupants involved in VvV collisions (Haworth and Debnath, 2013).

Their vulnerability can be further magnified when drivers commit a HAR. A study conducted in Singapore found that the odds of a driver fleeing are 4.67 times more likely in VvB collisions when compared to VvV collisions (Tay et al., 2008). If there are no witnesses to report a HAR, medical care for the bicyclist may be delayed (Tay et al., 2008). Delays for treatment of traumatic head injuries may worsen patient outcomes (Dinh et al., 2013). Without the auto insurance information of the fleeing driver, bicyclists are forced to navigate the compensation and litigation process, perhaps putting them at further risk for PTSD. Regardless of whether the perpetrator is later captured, the cost of medical aid to a bicyclist could exceed the liability limits of either party's medical or auto insurance. Indirect costs, such as those related to disability, can also be economically burdensome.

Over the last decade, cities have begun to prioritize bicycling as a green and active form of transportation. Bicyclists commuting to work have doubled from the years 2000 to 2009 in rural and urban areas (Pucher et al., 2011). In the latter, overall riding has increased three-fold (Pucher et al., 2011). Developments in bicycling infrastructure such as bicycle lanes and road diets have been, and continue to be, implemented across cities in the United States (Pucher et al., 2011), including in the City of Boston (City of Boston, 2013). If HARs increase as cities become more bicycle-friendly and ridership increases, it will be important to base prevention and mitigation efforts on significant predictors.

### 1.1. Previous work

A small number of studies have identified a multitude of factors that contribute to HARs (Aidoo et al., 2013; Kim et al., 2008; MacLeod et al., 2012; Solnick and Hemenway, 1995, 1994; Tay et al., 2010; Tay et al., 2009; Tay et al., 2008). These studies have generally focused on VvV or VvP collisions and have generated important findings. For example, drivers are less likely to leave the scene in collisions involving younger or older pedestrians (MacLeod et al., 2012; Solnick and Hemenway, 1994). Also, traffic and lighting conditions and day of the week contribute to a drivers' decision to flee (Solnick and Hemenway, 1994; Tay et al., 2010; Tay et al., 2009; Tay et al., 2008). In this study, we explore whether the factors that predict VvB HARs are similar to those identified in VvV or VvP HAR studies.

Some HAR studies selected cases from fatality administrative databases (MacLeod et al., 2012; Solnick and Hemenway, 1995, 1994), while others used police-reported collision data to conduct their HAR analyses (Aidoo et al., 2013; Kim et al., 2008; Tay et al., 2008). In the US, the Fatal Accident Reporting System (FARS) reliably captures comprehensive fatality data at the national level, making the data appealing. However, the limitation of FARS is that fatalities are relatively rare and arguably a non-representative subset of all collisions—because they do not include injuries and collisions. Police-reported collision data, which are considered the national standard for collision analyses in the US are more representative (National Highway Traffic Safety Administration, 2014b).

Our observational study used an electronic registry of all police-reported bicycle collisions in Boston, Massachusetts (United States). This allowed for a reasonable estimate of the incidence of a HAR and limited the types of biases that occur in studies that select their cases based on the outcome of the event (such as fatality or injury). Our data identified whether a collision was a HAR and included factors that may be predictive of a HAR such as road and bicyclist characteristics. The registry allowed us to examine variables not generally found in standard police reports (such as whether the vehicle was a taxi). This is because in addition to forced-choice information in the collision report, we took into account information from open-ended text narratives written by police officers.

### 1.2. Hypotheses: injury, gender, taxi

Drivers' motivation to flee the scene after a collision has rarely been explored (MacLeod et al., 2012). However, collision studies

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