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Walking under the influence of the alcohol: A case study of pedestrian crashes in Tennessee

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ABSTRACT

Alcohol adversely affects human behavior and judgment, and it is one of the contributing factors in traffic crashes. Although a large body of research has investigated driving behavior under the influence of the alcohol, to the best of our knowledge, no study has investigated the crash characteristics of the pedestrians under the influences of the alcohol. Tennessee Police Crash Data from 2011 to 2016 was used in this study to identify crashes between motor vehicles and pedestrians who were walking under the influence of alcohol (WUI). Results indicate that the number of fatally injured pedestrians for WUI cases has increased since 2011. Alcohol was present in 7% of the pedestrian crashes. Tested pedestrians averaged BAC levels of 0.17 g/dL. As pedestrian injury severity increased, the share of the WUI crashes increased. WUI contributed in 22% of the fatally injured pedestrian and only in 2% of the pedestrian crashes with no-injury. Comparisons indicate that the WUI crashes had their characteristics, which distinguished them from non-WUI crashes. Analysis indicates that 83% of the WUI crashes occurred in the nights; moreover, 54%, 69%, and 85% of WUI crashes respectively occurred on weekends, mid-block section of the road, and areas with no traffic control device. Results of a binary logit regression indicate that pedestrian's age, males, posted speed limit, and nighttime crashes had a positive association with the WUI crashes. On the other hand, urban context, intersection crashes, driver maneuvers (i.e., parking-related, turning, and straight), and daylight had a negative association with the WUI crashes. Findings are discussed in line with road safety countermeasures.

1. Introduction

Walking has several health benefits for individuals and imposes the lowest negative externalities to the transportation system. However, pedestrians in the transportation networks are vulnerable to traffic crashes, often due to the poor design of transportation networks and lack of protection against impact. Due to the vulnerability and lack of protection systems, pedestrians have one of the highest injury risks among road users (Elvik et al., 2009).

Pedestrian crashes have gone up dramatically in the past few years (IIHS, 2018). In the United States, pedestrians represent about 15% of traffic fatalities (NHTSA, 2017b). Similar to other road users (e.g., drivers, bicyclists) (Jones and Lacey, 2001; Crocker et al., 2010; Eichelberger et al., 2017; Eichelberger et al., 2018; Hezaveh et al., 2018b, Mohamadi Hezaveh et al., 2018), alcohol consumption is one of the risk factors that adversely affect traffic safety for pedestrians. Out of 5,295 pedestrians who died in traffic crashes in the US in 2015, 2,022 (38%) pedestrians had alcohol in their system at the time of the crash; 1,800 (34%) had BAC equals or greater than 0.08 g/dl in their body (NHTSA, 2017b). Several studies investigated alcohol and drug consumption by motorized road users; only a small number of studies examined the role of alcohol consumption for non-motorized road users, particularly pedestrians.

Alcohol consumption impairs pedestrians' judgment on speed, the proximity of a crossing vehicle (Clayton and Colgan, 2001), and decision to cross streets (McLean and Offler, 1980; Oxley et al., 2006). Oxley et al. (2006) studied road crossing behavior and reported that highly intoxicated participants showed some impaired awareness and tended to engage in risky road crossings. In addition, highly intoxicated participants had difficulty integrating speed and distance information in a timely manner, which is necessary to select safe gaps in the traffic. Struik et al. (1988) reported that intoxicated pedestrians might be slower to avoid an oncoming vehicle, more likely to walk into the path of a moving vehicle, and more likely to fall asleep on or near the roadway.

Several studies indicated that alcohol-impaired pedestrians were more involved in pedestrian crashes (Miles-Doan, 1996) and they are more likely to suffer from severe or fatal injuries in comparison to non-

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intoxicated pedestrians (Blomberg and Fell, 1979; Miles-Doan,1996; Öström and Eriksson, 2001; Kim et al., 2008; Clifton et al., 2009; Hezaveh et al., 2018a). Öström and Eriksson (2001) also stated that intoxicated pedestrians suffered more head injuries compared to non-intoxicated pedestrians. Dultz and Frangos (2013) confirmed that intoxicated pedestrians usually sustain more severe injuries, which required longer duration hospital stays.

Analyzing trauma and hospital data in several studies showed that male pedestrians (Holubowycz, 1995; Öström and Eriksson, 2001; Plurad et al., 2006; Prijon and Ermenc, 2009; Eichelberger et al., 2017; Ortiz and Ramnarayan, 2017; Eichelberger et al., 2018) and middle-aged pedestrians (Holubowycz, 1995; Öström and Eriksson, 2001; Demetriades et al., 2004; Edirisinghe et al., 2015) were usually at higher risks of WUI crashes compared to the female pedestrians and other age cohorts. Shankar (2003) reported that pedestrians ages 30–39 who were killed in single-vehicle crashes in 2001 had the highest proportions of BACs of 0.08 g/dL and higher, with ages 20–29 and 40–49 closely following. Analysis of pedestrian fatality trend between 2003 and 2015 from the FARS databases indicated that adults between 21–34 years old were the most common age group among alcohol-involved fatality than any other age groups (Ortiz and Ramnarayan, 2017). Moreover, minor ethnicities (i.e., Hispanics and Indian Americans) were more likely to be involved in alcohol-involved pedestrian crashes (Cornwell et al., 1998; Demetriades et al., 2004; Plurad et al., 2006; Ortiz and Ramnarayan, 2017).

On the subject of the crash environment, Eichelberger et al. (2017) reported nighttime, weekend, and urban crashes had significant positive association with fatally injured pedestrian and bicyclists with high alcohol impairment. Levine (2017) in a study of alcohol-related crashes in Houston, TX, concluded that the likelihood of alcohol-related crashes for pedestrians and drivers are higher in road segments close to late night bars and restaurant in urban areas. Lindsay (2012) in a study in Southern Australia consist of 53 alcohol-impaired pedestrians, reported that impaired pedestrian crashes were more likely to occur in the metropolitan area (90%), in mid-block section (64%) of the roads, and on major roads (58%).

Although the share of fatally injured pedestrians in the US with high BAC ($\geq$0.08 g/dL) declined from 45% in 1982 to 35% in 2014, still intoxicated pedestrian, constitute a noteworthy share of pedestrian fatalities (Eichelberger et al., 2017; Eichelberger et al., 2018). While the share of fatally injured intoxicated pedestrians is known, the true share of the walking under the influence of the alcohol crashes (WUI) is not known. The WUI share in studies varied depending on the context of the study, the population of the study, the source of the data, and eventually the BAC threshold, which was used to screen the drunk pedestrians (e.g., Harruff et al., 1998; Demetriades et al., 2004). A study of 180 killed pedestrians in Seattle indicated that 43 cases (24%; 33 males, 10 females) of the pedestrian had alcohol in their blood at time of the crashes with average BAC of 0.16 g/dL (30 cases higher than 0.10 g/dL) (Harruff et al., 1998). Demetriades et al. (2004) in a study of the trauma cases in the Los Angeles County and University of Southern California Trauma Center during the period of January 2000 to May 2003 found that 24 (19 males, 5 females) out of 48 pedestrians involved in traffic crashes were intoxicated at the time.

Alcohol is a contributing factor to traffic crashes that put pedestrians in more unsafe situations, which increases the likelihood of the crashes and injury severities. Studies that investigated WUI crashes relied heavily on health-oriented data (e.g., hospital data, emergency department) and mainly focused on the killed or severely injured pedestrians. One limitation of WUI studies to date is that the smaller sample usually consisted of a limited number of observations in comparison to the actual number of reported pedestrian crashes. Moreover, the characteristics of these crashes are not known (i.e., hospital data tends to include little information regarding the crash characteristics traditionally available in police reports).

This study has four aims. First, identify the WUI share in pedestrian crashes regardless of injury severity, second, explore the WUI crash characteristics and compare it with non-WUI crashes. Moreover, identify the groups that have a higher likelihood of involvement in WUI crashes. Last, explore the association between characteristics of the pedestrian, road, and environment and the WUI crashes by using a binary logit model. Identifying risk factors, which contributes to the WUI crashes, would benefit researchers and policymakers to design proper countermeasures and interventions that target the WUI crashes.

2. Methodology

2.1. Data

The data in this study was provided by Tennessee Integrated Traffic Analysis Network (TITAN [https://titan.safety.tn.gov/]), a portal provided by Tennessee Highway Patrol as a repository for traffic crash and surveillance reports completed by Tennessee law enforcement agencies. Law enforcement agencies in Tennessee use TITAN to submit traffic crashes' reports and validate the crash data contained. Moreover, TITAN control for completion and the accuracy of the reports before storing the information (TITAN, 2018). TITAN follows the Model Minimum Uniform Crash Criteria guideline for ensuring the quality of the data (NHTSA, 2017a).

The traffic crash records from January 1, 2011, through December 31, 2016, were retrieved from TITAN. Each crash records included information about road user type (e.g., pedestrian) and evidence of alcohol impairment at the time of the crash as well as common data elements in police crash reports (NHTSA, 2017a). The injury severity in this database followed the KABCO scale for Tennessee provided by FHWA. In KABCO scale K, A, B, C, and O respectively stand for a crash with fatal injury, incapacitating injury, non-incapacitating evident injury, possible injury, and no-injury (FHWA, 2017).

Based on MMUCC recommendation, TITAN database also recorded the alcohol presence of the road users (i.e., drivers, non-motorists) at the time of the crash. Law enforcement officers report the alcohol or drug use when they are suspected or documented that at least one of road users involved in traffic crashes had used alcohol (NHTSA, 2017a). There are different methods and procedures for screening a drunk road user –including a pedestrian– by a police officer. In cases where a law enforcement officer suspects alcohol or drug impairment at the roadside based upon observations, officer may perform field sobriety test including behavioral tests such as horizontal gaze nystagmus, one-leg stand, and walk and turn tests (Hartman et al., 2016), or use a portable breath tester to perform a preliminary breath test or preliminary alcohol screening test (NHTSA, 2015). In addition, in specific cases (Richman and Jakobowski, 1994), a trained drug recognition experts officer can request the collection and analysis of an appropriate biological sample (i.e., urine, saliva, or blood) to obtain scientific evidence of the road user's alcohol or drug use (Hartman et al., 2016; NHTSA, 2015); the sampling process usually take place at a precinct, jail or similar locations as soon as possible (Richman and Jakobowski, 1994). In this study, we defined a WUI state as the presence of the alcohol in a pedestrian recorded by a police officer regardless of the BAC level and screening method (i.e., Observation, evidential test, behavioral method, and portable breath tester). The pedestrian was flagged as being under the influence of alcohol (binary) in TITAN if any screening method revealed intoxication. A supplemental data field included BAC if screening was performed.

2.2. Modeling approach

Presence of alcohol in pedestrians at the time of the crash is a discrete event with dichotomous nature. Binary logistic regression is one of the most practiced models for binary events (Washington et al., 2010). To model factors affecting whether a pedestrian was WUI, a binary logit model with the conventional significance level of 0.05 (as a