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Understanding the drowsy driving crash patterns from correspondence regression analysis

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Highlights

- Correspondence Regression Analysis was applied on a drowsy driving crash dataset.
- Several clusters present collective associations of attributes by dimensional reduction.
- Young drowsy drivers have risks on low-speed road during dark-lighted conditions.
- Truck drivers are in risks in rural areas with curve-level-elevated alignment.
- Rural area, multiple-passenger, old drivers are linked to fatal & severe crash risk.

Abstract

Abstract: Drowsy driving-related crashes have been a key concern in transportation safety. In Louisiana, 14% (1,758 out of 12,512) of police-reported drowsy driving-related crashes during 2015–2019 resulted in injury (fatal, severe, or moderate). Amid the calls for action against drowsy driving by national agencies, it is of paramount importance to explore the key reportable attributes of drowsy driving behaviors and their potential association with crash severity. *Method:* This study used 5-years (2015–2019) of crash data and utilized the correspondence regression analysis method to identify the key collective associations of attributes in drowsy driving-related crashes and interpretable patterns based on injury levels. *Results:* Several drowsy driving-related crash patterns were identified through crash clusters – afternoon fatigue crashes by middle-aged female drivers on urban multilane curves, crossover crashes by young drivers on low-speed roadways, crashes by male drivers during dark rainy conditions, pickup truck crashes in manufacturing/industrial areas, late-night crashes in business and residential districts, and heavy truck crashes on elevated curves. Several attributes – scattered residential areas indicating rural areas, multiple passengers, and older drivers (aged more than 65 years) – showed a strong association with fatal and severe injury crashes. *Practical Applications:* The findings of this study are expected to help researchers, planners, and policymakers in understanding and developing strategic mitigation measures to prevent drowsy driving.

Introduction

Drowsy driving is a growing risky behavior that is greatly affecting transportation safety (Yong et al., 2016). In transportation safety analysis, the term ‘drowsy’ is interchangeably used with ‘fatigued’ and ‘sleepy.’ In police crash reports, this driving condition is identified if the driver experiences a temporary loss of consciousness, is found to be drowsy or asleep, or is operating at a reduced physical or mental capacity due to weariness. The ‘ill’ condition of the driver is also often connected with drowsy driving. The ‘drowsy’ category in the crash report usually presents a distinct identifiable driving condition. Drowsy drivers could exhibit a range of expressions – from facial relaxation and restless movement to a lack of apparent activity for moderate to complete drowsiness (Klauer et al., 2006).

Drowsy driving is mostly related to drivers’ sleep deprivation. The recent trend suggests that a lack of quality sleep has become a global problem, especially in developed countries (Phillips, 2020). A myriad of issues related to lifestyle factors, including but not limited to work pressure and technological enhancement, are aligned with sleep deprivation (National Highway Traffic Safety Administration [NHTSA], 2020). By impairing cognitive function, a lack of sleep could cause poor attention and working memory (Alhola & Polo-Kantola, 2007) and is likely to have a serious impact on drivers’ driving awareness and defensive driving skills. Being awake for 21 hours could mimic the cognitive condition of blood alcohol concentration (BAC) of the legal limit (0.08%; Fischer, 2016), and the impairment due to wakefulness after 24 hours is equivalent to a BAC of 0.1% (Dawson & Reid, 1997). The deteriorated capability of decision-making of drowsy drivers could translate to isolated irrecoverable movements, which poses a serious crash risk to the drivers themselves and to other road users. Additionally, drug-related fatigue or driving after taking sleep medication can also cause drowsy driving-related traffic crashes (Brown et al., 2015, Verster et al., 2018).

Self-reported sleep duration decreased from 1985 into the 2000s in the United States as Ford, Cunningham, and Croft (2015) found an increase in the percentage of adults who reported sleeping 6 hours or less in a 24-hour period in each year from 2004 to 2012 compared to 1985 in the National Health Interview Survey (NHIS) data. Another study with NHIS data by Sheehan, Frochen, Walsemann, and Ailshire (2019) estimated that prevalence of short sleep duration was relatively stable from 2004 to 2012, followed by an increasing trend toward short sleep (6 hours or less) beginning in 2013 and continuing through 2017. The National Transportation Safety Board (NTSB) identified drowsy driving as a contributing factor in 20% of the major investigations of transportation crashes that occurred

between 2001 to 2012 (NTSB, 2018). The census of fatal crashes by NHTSA indicates that fatal crashes associated with driver conditions of drowsy/asleep/fatigued/ill/blackout comprised of 1,240 fatal crashes (National Center for Statistics and Analysis, n.d.). In Louisiana, 14% (1,758 out of 12,512) of police-reported drowsy driving crashes resulted in a confirmed (fatal, severe, or moderate) injury during 2015–2019. Despite the considerably large frequency of crashes, drowsy driving crash factors have not been sufficiently studied.

As one of the consequential societal impacts of fatigue due to prolonged wakefulness, the growing risk of drowsy driving will most likely continue to affect traffic safety in the coming years. Only two states in the United States – Arkansas and New Jersey – have undertaken a legislative approach to prevent drowsy driving. However, complicacies in establishing enforceable parameters using a legislative approach against drowsy driving (National Conference of State Legislatures, 2018) have been recognized, which could be attributed to a lack of understanding of critical factors associated with drowsy driving and its severity outcomes. Prior to combating the issue of drowsy driving, investigation of distinctive associative factors of drowsy driving is necessary and could also largely benefit the application of potential strategic countermeasures.

Section snippets

Prior studies and objectives of the current study

To date, a number of approaches have been undertaken to understand the drowsy driving issues. A total of 701 severe, moderate, and minor crashes that occurred during the second Strategic Highway Research Program (SHRP2) Naturalistic Driving Study (NDS) were identified to have involved drowsy driving based on videos using the PERCLOS (the percentage of eyelid closure over the pupil over time) measure in the preceding minutes leading to crashes (Owens et al., 2016). With Fisher's exact tests, the …

Data preparation

To explore drowsy driving characteristics and their potential associations with crash severity, the researchers used the crash dataset of 2015–2019, which was extracted from the crash databases collected from the Louisiana Department of Transportation and Development (DOTD). The raw data were assembled in MS Access files for each year and consisted of several data tables, three of which were necessary for the drowsy driving dataset compilation – roadway data, crash data, and vehicle data. The …

Results and discussions

The results of the correspondence regression analysis are presented through eigenvalues. The distribution of the 'eigenvalues' provides measures of 'explanatory power' of each latent axis. Equivalent to latent variables, these underlying axes are often termed 'principal axes.' The results of eigenvalues are presented in three ways: first, the actual eigenvalues; second, percentages showing the relative values; and third, cumulative percentages showing the cumulative relative values. The sum of …

Conclusions

Due to the rapidly increasing fatigue due to prolonged wakefulness in recent years, the call for action to address the long-withstanding problem of drowsy driving is more important now than at any previous time. Sleep deprivation, drug-associated fatigue, and driving after taking sleep-inducing medication are the primary factors of driving-

related drowsiness. For multidisciplinary preventative actions to lower drowsy and fatigue-related crashes, an improved understanding of drowsy driving crash …

Conflict of Interest

All the authors have no conflict of interest with the funding entity and any organization mentioned in this article in the past three years that may have influenced the conduct of this research and the findings. …

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