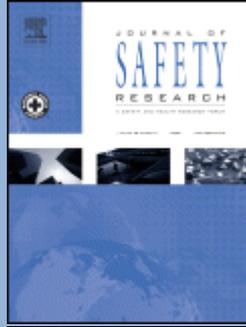


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Lauren Meredith, Christopher Hurren, Elizabeth Clarke, Michael Fitzharris, Matthew Baldock, Liz de Rome, Jake Olivier, Julie Brown. *Validation of the abrasion resistance test protocols and performance criteria of EN13595: The probability of soft tissue injury to motorcycle riders by abrasion resistance of their clothing.* Pages 1-7.

Introduction: Motorcyclists represent an increasing proportion of road users globally and are increasingly represented in crash statistics. Soft tissue injuries are the most common type of injuries to crashed motorcyclists. These injuries can be prevented through the use of protective clothing designed for motorcycle use. However, the quality of such clothing is not controlled in many countries around the world. A European Standard was developed to assess the performance of clothing but as this is not mandatory, clothing certified to this Standard is difficult to obtain. Given the importance of this Standard, and that it has been validated only once, further validation work is required. **Methods:** In-depth crash investigation data were used to investigate the relationship between the abrasion resistance performance of clothing and real-world injury outcome. Clothing was collected from riders who crashed on public roads in Sydney and Newcastle, Australia. This clothing was tested according to the EU Standard and the time to hole was recorded. Hospital medical records were reviewed and the association between a rider suffering a soft tissue injury and the time-to-hole for the garment was examined. **Results:** The probability of soft tissue injury for Level 1 Standard garments was between 40–60%, but more than 60% of garments tested failed to meet the minimum requirement. **Conclusions:** The findings of this study provide qualified support for the Standard, with a marginal association between time-to-hole and injury being found. **Practical Implications:** This work supports the need for improved safety performance and an increased number of high performing garments being available to motorcyclists.

- **Keywords:** Motorcycle; Abrasion; Protective clothing

Athanasios Theofilatos. *Incorporating real-time traffic and weather data to explore road accident likelihood and severity in urban arterials.* Pages 9-21.

Introduction: The effective treatment of road accidents and thus the enhancement of road safety is a major concern to societies due to the losses in human lives and the economic and social costs. The investigation of road accident likelihood and severity by

utilizing real-time traffic and weather data has recently received significant attention by researchers. However, collected data mainly stem from freeways and expressways. Consequently, the aim of the present paper is to add to the current knowledge by investigating accident likelihood and severity by exploiting real-time traffic and weather data collected from urban arterials in Athens, Greece. **Method:** Random Forests (RF) are firstly applied for preliminary analysis purposes. More specifically, it is aimed to rank candidate variables according to their relevant importance and provide a first insight on the potential significant variables. Then, Bayesian logistic regression as well finite mixture and mixed effects logit models are applied to further explore factors associated with accident likelihood and severity respectively. **Results:** Regarding accident likelihood, the Bayesian logistic regression showed that variations in traffic significantly influence accident occurrence. On the other hand, accident severity analysis revealed a generally mixed influence of traffic variations on accident severity, although international literature states that traffic variations increase severity. Lastly, weather parameters did not find to have a direct influence on accident likelihood or severity. **Conclusions:** The study added to the current knowledge by incorporating real-time traffic and weather data from urban arterials to investigate accident occurrence and accident severity mechanisms. **Practical application:** The identification of risk factors can lead to the development of effective traffic management strategies to reduce accident occurrence and severity of injuries in urban arterials.

- **Keywords:** Accident likelihood; Accident severity; Real-time data; Urban arterials

Nils Lubbe. *Brake reactions of distracted drivers to pedestrian Forward Collision Warning systems.* Pages 23-32.

Introduction: Forward Collision Warning (FCW) can be effective in directing driver attention towards a conflict and thereby aid in preventing or mitigating collisions. FCW systems aiming at pedestrian protection have been introduced onto the market, yet an assessment of their safety benefits depends on the accurate modeling of driver reactions when the system is activated. This study contributes by quantifying brake reaction time and brake behavior (deceleration levels and jerk) to compare the effectiveness of an audio-visual warning only, an added haptic brake pulse warning, and an added Head-Up Display in reducing the frequency of collisions with pedestrians. Further, this study provides a detailed data set suited for the design of assessment methods for car-to-pedestrian FCW systems. **Method:** Brake response characteristics were measured for heavily distracted drivers who were subjected to a single FCW event in a high-fidelity driving simulator. The drivers maintained a self-regulated speed of 30 km/h in an urban area, with gaze direction diverted from the forward roadway by a secondary task. **Results:** Collision rates and brake reaction times differed significantly across FCW settings. Brake pulse warnings resulted in the lowest number of collisions and the shortest brake reaction times (mean 0.8 s, SD 0.29 s). Brake jerk and deceleration were independent of warning type. Ninety percent of drivers exceeded a maximum deceleration of 3.6 m/s² and a jerk of 5.3 m/s³. **Conclusions:** Brake pulse warning was the most effective FCW interface for preventing collisions. In addition, this study presents the data required for driver modeling for car-to-pedestrian FCW similar to Euro NCAP's 2015 car-to-car FCW assessment. **Practical applications:** Vehicle manufacturers should consider the introduction of brake pulse warnings to their FCW systems. Euro NCAP could introduce an assessment that quantifies the safety benefits of pedestrian FCW systems and thereby aid the proliferation of effective systems.

- **Keywords:** Driver behavior; FCW; Haptic; Head-up display; Reaction time

Myeonghyeon Kim, Seung-Young Kho, Dong-Kyu Kim. *Hierarchical ordered model for injury severity of pedestrian crashes in South Korea.* Pages 33-40.

Introduction: The high percentage of fatalities in pedestrian-involved crashes is a critical social problem. The purpose of this study is to investigate factors influencing injury severity in pedestrian crashes by examining the demographic and socioeconomic characteristics of the regions where crashes occurred. **Method:** To understand the correlation between the unobserved characteristics of pedestrian crashes in a defined region, we apply a hierarchical ordered model, in which we set crash characteristics as lower-level variables and municipality characteristics as upper-level. Pedestrian crash data were collected and analyzed for a three-year period from 2011 to 2013. The estimation results show the statistically significant factors that increase injury severity of pedestrian crashes. Results: At the crash level, the factors associated with increased severity of pedestrian injury include intoxicated drivers, road-crossing pedestrians, elderly pedestrians, heavy vehicles, wide roads, darkness, and fog. At the municipality level, municipalities with low population density, lower level of financial independence, fewer doctors, and a higher percentage of elderly residents experience more severe pedestrian crashes. Municipalities ranked as having the top 10% pedestrian fatality rate (fatalities per 100,000 residents) have rates 7.4 times higher than municipalities with the lowest 10% rate of fatalities. Their demographic and socioeconomic characteristics also have significant differences. The proposed model accounts for a 7% unexplained variation in injury severity outcomes between the municipalities where crashes occurred. Conclusion: To enhance the safety of vulnerable pedestrians, considerable investments of time and effort in pedestrian safety facilities and zones should be made. More certain and severe punishments should be also given for the traffic violations that increase injury severity of pedestrian crashes. Furthermore, central and local governments should play a cooperative role to reduce pedestrian fatalities. Practical applications: Based on our study results, we suggest policy directions to enhance pedestrian safety.

- **Keywords:** Pedestrian crash; Injury severity; Hierarchical ordered model; Municipality

Matteo Picchio, Jan C. van Ours. *Temporary jobs and the severity of workplace accidents.* Pages 41-51.

Introduction. From the point of view of workplace safety, it is important to know whether having a temporary job has an effect on the severity of workplace accidents. We present an empirical analysis on the severity of workplace accidents by type of contract. **Method.** We used microdata collected by the Italian national institute managing the mandatory insurance against work related accidents. We estimated linear models for a measure of the severity of the workplace accident. We controlled for time-invariant fixed effects at worker and firm levels to disentangle the impact of the type of contract from the spurious one induced by unobservables at worker and firm levels. **Results.** Workers with a temporary contract, if subject to a workplace accident, were more likely to be confronted with severe injuries than permanent workers. When correcting the statistical analysis for injury under-reporting of temporary workers, we found that most of, but not all, the effect is driven by the under-reporting bias. **Conclusions.** The effect of temporary contracts on the injury severity survived the inclusion of worker and firm fixed effects and the correction for temporary workers' injury under-reporting. This, however, does not exclude the possibility that, within firms, the nature of the work may vary between different categories of workers. For example, temporary workers might be more likely to be assigned dangerous tasks because they might have less bargaining power. **Practical implications.** The findings will help in designing public policy effective in increasing temporary workers' safety at work and limiting their injury under-reporting.

- **Keywords:** Workplace accidents; Injury severity; Temporary jobs; Contract type; Injury under-reporting

Clark Calabrese, Bianka Mejia, Catherine A. McInnis, Megan France, Eric Nadler, Thomas G. Raslear. *Time of day effects on railroad roadway worker injury risk. Pages 53-64.*

Introduction: The purpose of this study is to examine how time of day affects injury risk of railroad maintenance of way employees and signalmen (roadway workers). Railroads reported 15,654 serious roadway worker injuries between 1997 and 2014. Roadway workers primarily work outdoors on or near railroad tracks and frequently encounter hazardous conditions. To avoid closing an active rail line during peak hours, railroads sometimes require roadway workers to work at night. Previous studies of roadway worker injury have not adequately accounted for exposure to time of day effects, nor have they investigated the human factors issues contributing to roadway worker injury.

Method: The Federal Railroad Administration (FRA) database of injury reports provided data for circadian rhythm models of the odds of fatal and nonfatal injuries. The FRA database and fatal injury investigation reports also permitted an analysis of the circumstances and the human factors issues associated with injuries that occur at different times of day. **Results:** Odds of injury increased during nighttime work. The odds of nonfatal injury for both roadway worker crafts rose above 9:1 in the early morning hours. The relative odds of a fatal injury also increased significantly at night. A human factors analysis suggested that during all three shifts most nonfatal injuries involve workload, but workload was not identified as a factor in fatal injuries.

Conclusions: Nighttime work is more hazardous for roadway workers than daytime work. Several factors related to fatigue and other conditions appear to increase the risk of injury during the outdoor, nighttime work required of roadway workers. **Practical application:** For practical reasons, nighttime roadway work is sometimes unavoidable. Therefore, new practices for nighttime work must be developed to adequately address fatigue and protect roadway workers from harm.

- **Keywords:** Fatigue; Circadian; Roadway worker; Injury analysis; Human factors

Jessica S. Jermakian, Shan Bao, Mary Lynn Buonarosa, James R. Sayer, Charles M. Farmer. *Effects of an integrated collision warning system on teenage driver behavior. Pages 65-75.*

Introduction: Crash warning systems have been shown to provide safety benefits, but no studies have examined how teenagers respond. This study sought to find out whether young, inexperienced drivers change behavior in response to warnings. **Methods:** Forty 16–17 year-olds drove an instrumented vehicle equipped with a system that warned for lane departures and potential rear-end and lane change/merge crashes. Participants were randomly assigned to experimental or control groups, and their driving was monitored for 14 weeks during 2011–12. For the experimental group, this included a treatment period, when crash alerts were received by drivers, and baseline and post-treatment periods, when warnings were recorded but not received. The control group never received warnings. Data were analyzed to determine whether warnings were associated with changes in driving behavior. **Results:** A total of 15,039 trips were analyzed. Lane drifts accounted for 73% of warnings. Forward collision warning rates doubled for all drivers during the treatment period and continued at an increased rate post-treatment. This was likely a result of the fact that, as time went on, all drivers spent more time following vehicles at close distances. Receiving alerts was associated with effects on following and lane-changing behavior, including more time spent following at close distances (17%), fewer lateral drifts (37%) and fewer unsignaled lane changes (80%). Receiving warnings wasn't associated with an increased likelihood of engaging in secondary tasks. **Conclusions:** Warning systems may result in improved lane-keeping and turn-signal behaviors by novice drivers, but there is some indication they may result

in more close-following behaviors. **Practical applications:** There is some evidence that lane departure warning may improve turn-signal use for young drivers. While there is no evidence of safety benefits from the other types of warnings, there is some evidence of an increase in close-following behavior but no increase in secondary tasks due to the presence of those capabilities.

- **Keywords:** Teenage drivers; Crash avoidance; Naturalistic driving study

Matthew O'Connell, Kristin Delgado, Amie Lawrence, Mavis Kung, Esteban Tristan. *Predicting workers' compensation claims and disciplinary actions using SecureFit®: Further support for integrative models of workplace safety.* Pages 77-81.

Introduction: A growing body of applied research has identified certain psychological traits that are predictive of worker safety. However, most of these studies suffer from an overreliance on common method bias caused by self-report measures of both: (a) personal factors such as personality traits; and (b) outcomes such as safety behaviors and injuries. **Method:** This study utilized archival data from 796 employees at a large U.S. automobile manufacturer. Data were gathered on a pre-employment assessment, SecureFit®, that measured key personality characteristics such as conscientiousness, locus of control, and risk taking. In addition, objective measures of workers' compensation claims and disciplinary actions were also gathered. **Results:** The results indicated that disciplinary actions and workers' compensation claims were strongly correlated. It also demonstrated that the pre-employment assessment was able to predict both disciplinary actions and workers' compensation claims up to 12 months in the future. Screening out just 8% of the applicant sample using the assessment would have resulted in a 35% reduction in disciplinary actions and 46% in workers' compensation claims, respectively. **Conclusions:** The study found a very strong relationship between counterproductive work behaviors (CWBs), such as not following rules, and workers' compensation claims. It also found a strong relationship between a combination of personality traits that have been shown to be associated with both variables, although the current study was able to demonstrate that relationship with objective measure of both variables. **Practical applications:** Individuals who receive disciplinary actions for things such as not following rules, not coming to work on time, etc. are significantly more likely to also be involved in serious safety incidents, and vice versa. Identifying those individuals early on in the hiring process and screening them out can significantly reduce the number of CWBs as well as workers' compensation claims.

- **Keywords:** Personality; Safety behavior; Counterproductive work behaviors; Prediction; Assessment

Wen Hu. *Raising the speed limit from 75 to 80 mph on Utah rural interstates: Effects on vehicle speeds and speed variance.* Pages 83-92.

Introduction: In November 2010 and October 2013, Utah increased speed limits on sections of rural interstates from 75 to 80 mph. Effects on vehicle speeds and speed variance were examined. **Methods:** Speeds were measured in May 2010 and May 2014 within the new 80 mph zones, and at a nearby spillover site and at more distant control sites where speed limits remained 75 mph. Log-linear regression models estimated percentage changes in speed variance and mean speeds for passenger vehicles and large trucks associated with the speed limit increase. Logistic regression models estimated effects on the probability of passenger vehicles exceeding 80, 85, or 90 mph and large trucks exceeding 80 mph. **Results:** Within the 80 mph zones and at the spillover location in 2014, mean passenger vehicle speeds were significantly higher (4.1% and 3.5%, respectively), as were the probabilities that passenger vehicles exceeded 80 mph (122.3% and 88.5%, respectively), than would have been expected without the speed limit increase. Probabilities that passenger vehicles exceeded 85 and 90 mph were non-

significantly higher than expected within the 80 mph zones. For large trucks, the mean speed and probability of exceeding 80 mph were higher than expected within the 80 mph zones. Only the increase in mean speed was significant. Raising the speed limit was associated with non-significant increases in speed variance. **Conclusions:** The study adds to the wealth of evidence that increasing speed limits leads to higher travel speeds and an increased probability of exceeding the new speed limit. Results moreover contradict the claim that increasing speed limits reduces speed variance. **Practical applications:** Although the estimated increases in mean vehicle speeds may appear modest, prior research suggests such increases would be associated with substantial increases in fatal or injury crashes. This should be considered by lawmakers considering increasing speed limits.

- **Keywords:** Speed limit increase; Vehicle speeds; Passenger vehicle speeds; Large truck speeds; Speed variance

Lynda S. Robson, Selahadin Ibrahim, Sheilah Hogg-Johnson, Ivan A. Steenstra, Dwayne Van Eerd, Benjamin C. Amick III. *Developing leading indicators from OHS management audit data: Determining the measurement properties of audit data from the field.* Pages 93-103.

Introduction: OHS management audits are one means of obtaining data that may serve as leading indicators. The measurement properties of such data are therefore important. This study used data from Workwell audit program in Ontario, a Canadian province. The audit instrument consisted of 122 items related to 17 OHS management elements. The study sought answers regarding (a) the ability of audit-based scores to predict workers' compensation claims outcomes, (b) structural characteristics of the data in relation to the organization of the audit instrument, and (c) internal consistency of items within audit elements. **Method:** The sample consisted of audit and claims data from 1240 unique firms that had completed one or two OHS management audits during 2007–2010. Predictors derived from the audit results were used in multivariable negative binomial regression modeling of workers' compensation claims outcomes. Confirmatory factor analyses were used to examine the instrument's structural characteristics. Kuder–Richardson coefficients of internal consistency were calculated for each audit element. **Results:** The ability of audit scores to predict subsequent claims data could not be established. Factor analysis supported the audit instrument's element-based structure. KR-20 values were high (≥ 0.83). **Conclusions:** The Workwell audit data display structural validity and high internal consistency, but not, to date, construct validity, since the audit scores are generally not predictive of subsequent firm claim experience. Audit scores should not be treated as leading indicators of workplace OHS performance without supporting empirical data. **Practical applications:** Analyses of the measurement properties of audit data can inform decisionmakers about the operation of an audit program, possible future directions in audit instrument development, and the appropriate use of audit data. In particular, decision-makers should be cautious in their use of audit scores as leading indicators, in the absence of supporting empirical data.

- **Keywords:** Performance measurement; Audit; Leading indicator; Management system

Jonathan DiGioia, Kari Edison Watkins, Yanzhi Xu, Michael Rodgers, Randall Guensler. *Safety impacts of bicycle infrastructure: A critical review.* Pages 105-119.

Problem and method: This paper takes a critical look at the present state of bicycle infrastructure treatment safety research, highlighting data needs. Safety literature relating to 22 bicycle treatments is examined, including findings, study methodologies, and data sources used in the studies. Some preliminary conclusions related to research

efficacy are drawn from the available data and findings in the research. **Results and discussion:** While the current body of bicycle safety literature points toward some defensible conclusions regarding the safety and effectiveness of certain bicycle treatments, such as bike lanes and removal of on-street parking, the vast majority treatments are still in need of rigorous research. Fundamental questions arise regarding appropriate exposure measures, crash measures, and crash data sources. **Practical applications:** This research will aid transportation departments with regard to decisions about bicycle infrastructure and guide future research efforts toward understanding safety impacts of bicycle infrastructure.

- **Keywords:** Bicycle treatment; Cyclist safety; Bicycle data collection; Crash risk; Crash modification factor

Inmaculada Silla, Joaquin Navajas, G. Kenneth Koves. *Organizational culture and a safety-conscious work environment: The mediating role of employee communication satisfaction.* Pages 121-127.

Introduction: A safety-conscious work environment allows high-reliability organizations to be proactive regarding safety and enables employees to feel free to report any concern without fear of retaliation. Currently, research on the antecedents to safety-conscious work environments is scarce. **Method:** Structural equation modeling was applied to test the mediating role of employee communication satisfaction in the relationship between constructive culture and a safety-conscious work environment in several nuclear power plants. **Results:** Employee communication satisfaction partially mediated the positive relationships between a constructive culture and a safety-conscious work environment. **Conclusions:** Constructive cultures in which cooperation, supportive relationships, individual growth and high performance are encouraged facilitate the establishment of a safety-conscious work environment. This influence is partially explained by increased employee communication satisfaction. **Practical application:** Constructive cultures should be encouraged within organizations. In addition, managers should promote communication policies and practices that support a safety-conscious work environment.

- **Keywords:** High reliability organizations; Nuclear power plants; Constructive culture; Structural equation modeling (SEM)

Dyani Juanita Saxby, Gerald Matthews, Catherine Neubauer. *The relationship between cell phone use and management of driver fatigue: It's complicated.* Pages 129-140.

Introduction: Voice communication may enhance performance during monotonous, potentially fatiguing driving conditions (Atchley & Chan, 2011); however, it is unclear whether safety benefits of conversation are outweighed by costs. The present study tested whether personalized conversations intended to simulate hands-free cell phone conversation may counter objective and subjective fatigue effects elicited by vehicle automation. **Method:** A passive fatigue state (Desmond & Hancock, 2001), characterized by disengagement from the task, was induced using full vehicle automation prior to drivers resuming full control over the driving simulator. A conversation was initiated shortly after reversion to manual control. During the conversation an emergency event occurred. **Results:** The fatigue manipulation produced greater task disengagement and slower response to the emergency event, relative to a control condition. Conversation did not mitigate passive fatigue effects; rather, it added worry about matters unrelated to the driving task. Conversation moderately improved vehicle control, as measured by SDLP, but it failed to counter fatigue-induced slowing of braking in response to an emergency event. Finally, conversation appeared to have a hidden danger in that it reduced drivers' insights into performance impairments when in a state of passive fatigue. **Conclusions:** Automation induced passive fatigue, indicated by loss of task engagement; yet, simulated cell phone conversation did not counter the subjective

automation-induced fatigue. Conversation also failed to counter objective loss of performance (slower braking speed) resulting from automation. Cell phone conversation in passive fatigue states may impair drivers' awareness of their performance deficits. **Practical applications:** Results suggest that conversation, even using a hands-free device, may not be a safe way to reduce fatigue and increase alertness during transitions from automated to manual vehicle control.

- **Keywords:** Passive fatigue; Countermeasures; Driver insight; Automation; Simulation

Wen Hu, Jessica B. Cicchino. *Effects of turning on and off red light cameras on fatal crashes in large U.S. cities. Pages 141-148.*

Introduction: This study updates estimates of effects of activating red light cameras and offers a first look at effects of turning them off. **Method:** Among 117 large U.S. cities with more than 200,000 residents in 2014, trends in citywide per capita rates of fatal red light running crashes and of all fatal crashes at signalized intersections were compared between 57 cities that initiated camera programs during 1992–2014 and 33 cities without cameras to examine effects of activating camera programs. Trends also were compared between 19 cities that removed cameras and 31 regionally matched cities with continuous camera programs to evaluate effects of terminating camera programs. Because several cities removed cameras during 2005–2008 and estimated effects might have been confounded by the subsequent economic downturn, primary analyses were limited to the 14 cities that removed cameras during 2010–2014 and 29 regionally matched cities with continuous camera programs. Poisson regression examined the relationship of activating and deactivating cameras with fatal crash rates. **Results:** After controlling for temporal trends in annual fatal crash rates, population density, and unemployment rates, rates of fatal red light running crashes and of all fatal crashes at signalized intersections were 21% and 14% lower, respectively, in cities with cameras after cameras were turned on than would have been expected without cameras; 30% and 16% higher, respectively, in 14 cities that terminated cameras during 2010–2014 after cameras were terminated than expected had cameras remained; and 18% and 8% higher, respectively, in all 19 cities that removed cameras, but not significantly. **Conclusions:** This study adds to the body of evidence that red light cameras can reduce the most serious crashes at signalized intersections, and is the first to demonstrate that removing cameras increases fatal crashes. **Practical applications:** Communities thinking about removing cameras should consider impacts to safety.

- **Keywords:** Turning on red light cameras; Turning off red light cameras; Fatal crash rates; Signalized intersections; Large cities

Sijun Shen, David M. Neyens. *Assessing drivers' response during automated driver support system failures with non-driving tasks. Pages 149-155.*

Introduction: With the increase in automated driver support systems, drivers are shifting from operating their vehicles to supervising their automation. As a result, it is important to understand how drivers interact with these automated systems and evaluate their effect on driver responses to safety critical events. This study aimed to identify how drivers responded when experiencing a safety critical event in automated vehicles while also engaged in non-driving tasks. **Method:** In total 48 participants were included in this driving simulator study with two levels of automated driving: (a) driving with no automation and (b) driving with adaptive cruise control (ACC) and lane keeping (LK) systems engaged; and also two levels of a non-driving task (a) watching a movie or (b) no non-driving task. In addition to driving performance measures, non-driving task performance and the mean glance duration for the non-driving task were compared between the two levels of automated driving. **Results:** Drivers using the automated

systems responded worse than those manually driving in terms of reaction time, lane departure duration, and maximum steering wheel angle to an induced lane departure event. These results also found that non-driving tasks further impaired driver responses to a safety critical event in the automated system condition. **Conclusion:** In the automated driving condition, driver responses to the safety critical events were slower, especially when engaged in a non-driving task. **Practical application:** Traditional driver performance variables may not necessarily effectively and accurately evaluate driver responses to events when supervising autonomous vehicle systems. Thus, it is important to develop and use appropriate variables to quantify drivers' performance under these conditions.

- **Keywords:** Adaptive cruise control; Lane keeping system; Non-driving tasks; Drivers' glances

Qing Cai, Mohamed Abdel-Aty, Jaeyoung Lee, Naveen Eluru. *Comparative analysis of zonal systems for macro-level crash modeling. Pages 157-166.*

Introduction: Macro-level traffic safety analysis has been undertaken at different spatial configurations. However, clear guidelines for the appropriate zonal system selection for safety analysis are unavailable. In this study, a comparative analysis was conducted to determine the optimal zonal system for macroscopic crash modeling considering census tracts (CTs), state-wide traffic analysis zones (STAZs), and a newly developed traffic-related zone system labeled traffic analysis districts (TADs). **Method:** Poisson lognormal models for three crash types (i.e., total, severe, and non-motorized mode crashes) are developed based on the three zonal systems without and with consideration of spatial autocorrelation. The study proposes a method to compare the modeling performance of the three types of geographic units at different spatial configurations through a grid based framework. Specifically, the study region is partitioned to grids of various sizes and the model prediction accuracy of the various macro models is considered within these grids of various sizes. **Results:** These model comparison results for all crash types indicated that the models based on TADs consistently offer a better performance compared to the others. Besides, the models considering spatial autocorrelation outperform the ones that do not consider it. **Conclusions:** Based on the modeling results and motivation for developing the different zonal systems, it is recommended using CTs for socio-demographic data collection, employing TAZs for transportation demand forecasting, and adopting TADs for transportation safety planning. **Practical Applications:** The findings from this study can help practitioners select appropriate zonal systems for traffic crash modeling, which leads to develop more efficient policies to enhance transportation safety.

- **Keywords:** Macro-level crash modeling; Census tracts; Traffic analysis zones; Traffic analysis districts; Poisson lognormal

Yuting Chen, Brenda McCabe, Douglas Hyatt. *Impact of individual resilience and safety climate on safety performance and psychological stress of construction workers: A case study of the Ontario construction industry. Pages 167-176.*

Introduction: The construction industry has hit a plateau in terms of safety performance. Safety climate is regarded as a leading indicator of safety performance; however, relatively little safety climate research has been done in the Canadian construction industry. Safety climate may be geographically sensitive, thus it is necessary to examine how the construct of safety climate is defined and used to improve safety performance in different regions. On the other hand, more and more attention has been paid to job related stress in the construction industry. Previous research proposed

that individual resilience may be associated with a better safety performance and may help employees manage stress. Unfortunately, few empirical research studies have examined this hypothesis. This paper aims to examine the role of safety climate and individual resilience in safety performance and job stress in the Canadian construction industry. **Method:** The research was based on 837 surveys collected in Ontario between June 2015 and June 2016. Structural equation modeling (SEM) techniques were used to explore the impact of individual resilience and safety climate on physical safety outcomes and on psychological stress among construction workers. **Results:** The results show that safety climate not only affected construction workers' safety performance but also indirectly affected their psychological stress. In addition, it was found that individual resilience had a direct negative impact on psychological stress but had no impact on physical safety outcomes. **Conclusions:** These findings highlight the roles of both organizational and individual factors in individual safety performance and in psychological well-being. **Practical applications:** Construction organizations need to not only monitor employees' safety performance, but also to assess their employees' psychological well-being. Promoting a positive safety climate together with developing training programs focusing on improving employees' psychological health — especially post-trauma psychological health — can improve the safety performance of an organization.

- **Keywords:** Safety climate; Positive psychological states; Canadian construction industry; Injuries and accidents; Psychological health

David G. Kidd, Mary Lynn Buonarosa. *Distracting behaviors among teenagers and young, middle-aged, and older adult drivers when driving without and with warnings from an integrated vehicle safety system.* Pages 177-185.

Introduction: Negative reinforcement from crash warnings may reduce the likelihood that drivers engage in distracted driving. Alternatively, drivers may compensate for the perceived safety benefit of crash warnings by engaging in distractions more frequently, especially at higher speeds. The purpose of this study was to examine whether warning feedback from an integrated vehicle-based safety system affected the likelihood that various secondary behaviors were present among drivers ages 16–17, 20–30, 40–50, and 60–70. **Method:** Participants drove an instrumented sedan with various collision warning systems for an extended period. Ten 5-second video clips were randomly sampled from driving periods at speeds above 25 mph and below 5 mph each week for each driver and coded for the presence of 11 secondary behaviors. **Results:** At least one secondary behavior was present in 46% of video clips; conversing with a passenger (17%), personal grooming (9%), and cellphone conversation (6%) were the most common. The likelihood that at least one secondary behavior was present was not significantly different during periods when drivers received warnings relative to periods without warnings. At least one secondary behavior was 21% more likely to be present at speeds below 5 mph relative to speeds above 25 mph; however, the effect of vehicle speed was not significantly affected by warning presence. Separate models for each of the five most common secondary behaviors also indicated that warnings had no significant effect on the likelihood that each behavior was present. **Conclusions:** Collision warnings were not associated with significant increases or decreases in the overall likelihood that teen and adult drivers engaged in secondary behaviors or the likelihood of the behaviors at speeds above 25 mph or below 5 mph. **Practical applications:** There was no evidence that forward collision warning and other technologies like those in this study will increase or decrease distracted driving.

- **Keywords:** Distracted driving; Collision warning systems; Driver age; Operant conditioning; Risk compensation

Anders Pousette, Pernilla Larsman, Mats Eklöf, Marianne Törner. *The relationship between patient safety climate and occupational safety climate in healthcare: A multi-level investigation.* Pages 187-198.

Introduction: Patient safety climate/culture is attracting increasing research interest, but there is little research on its relation with organizational climates regarding other target domains. The aim of this study was to investigate the relationship between patient safety climate and occupational safety climate in healthcare. **Method:** The climates were assessed using two questionnaires: Hospital Survey on Patient Safety Culture and Nordic Occupational Safety Climate Questionnaire. The final sample consisted of 1154 nurses, 886 assistant nurses, and 324 physicians, organized in 150 work units, within hospitals (117 units), primary healthcare (5 units) and elderly care (28 units) in western Sweden, which represented 56% of the original sample contacted. **Results:** Within each type of safety climate, two global dimensions were confirmed in a higher order factor analysis; one with an external focus relative the own unit, and one with an internal focus. Two methods were used to estimate the covariation between the global climate dimensions, in order to minimize the influence of bias from common method variance. First multilevel analysis was used for partitioning variances and covariances in a within unit part (individual level) and a between unit part (unit level). Second, a split sample technique was used to calculate unit level correlations based on aggregated observations from different respondents. Both methods showed associations similar in strength between the patient safety climate and the occupational safety climate domains. **Conclusions:** The results indicated that patient safety climate and occupational safety climate are strongly positively related at the unit level, and that the same organizational processes may be important for the development of both types of organizational climate. **Practical applications:** Safety improvement interventions should not be separated in different organizational processes, but be planned so that both patient safety and staff safety are considered concomitantly.

- **Keywords:** Safety culture; Organizational climate; Patient safety; Occupational safety; Multi-level analysis

Christopher DePesa, Toby Raybould, Shelley Hurwitz, Jarone Lee, Alice Gervasini, George C. Velmahos, Peter T. Masiakos, Haytham M.A. Kaafarani. *The impact of the 2007 graduated driver licensing law in Massachusetts on the rate of citations and licensing in teenage drivers.* Pages 199-204.

Objective: We recently demonstrated that the 2007 Massachusetts Graduated Driving Licensing (GDL) law decreased the rate of motor vehicle crashes in teenage drivers. To better understand this decrease, we sought to examine the law's impact on the issuance of driving licenses and traffic citations to teenage drivers. **Methods:** Citation and license data were obtained from the Massachusetts Department of Transportation. Census data were obtained from the Census Data Center. Two study periods were defined: pre-GDL (2002–2006) and post-GDL (2007–2012). Two populations were defined: the study population (aged 16–17) and the control population (aged 25–29). The rates of licenses per population were compared pre- vs. post-GDL for the study group. The numbers of total, state, and local citations per population were compared pre- vs. post-GDL for both populations. A sensitivity analysis was performed for the rates of citations using licenses issued as a denominator. **Results:** While licenses per population obtained by the study group decreased over the entire period, there was no change in the rate of decrease per year pre- vs. post-GDL (2.0% vs. 1.4%; $p = 0.6392$). In the study population, total, state, and local citations decreased post-GDL (17.8% vs. 8.1%, $p < 0.0001$; 3.7% vs. 2.2%, $p < 0.0001$; 14.1% vs. 5.8%, $p < 0.0001$, respectively). In the control group, total and state citations did not change (26.7% vs. 23.9%, $p = 0.3606$; 9.2% vs. 10.2%, $p = 0.3404$, respectively), and local citations decreased (17.5% vs. 13.7%, $p = 0.0389$).

The rates of decrease per year for total, state, and local citations were significantly greater in the study population compared with control ($p < 0.0001$, $p = 0.0002$, $p < 0.0001$, respectively). **Conclusions:** The 2007 GDL law in Massachusetts was associated with fewer traffic citations without a change in the rate of licenses issued to teenagers. These findings suggest that 2007 GDL may be improving driving habits as opposed to motivating teenagers to delay the issuing of licenses.

Gwen Bergen, Bethany A. West, Feijun Luo, Donna C. Bird, Katherine Freund, Richard H. Fortinsky, Loren Staplin. *How do older adult drivers self-regulate? Characteristics of self-regulation classes defined by latent class analysis.* Pages 205-210.

Problem: Motor-vehicle crashes were the second leading cause of injury death for adults aged 65–84 years in 2014. Some older drivers choose to self-regulate their driving to maintain mobility while reducing driving risk, yet the process remains poorly understood. **Methods:** Data from 729 older adults (aged ≥ 60 years) who joined an older adult ride service program between April 1, 2010 and November 8, 2013 were analyzed to define and describe classes of driving self-regulation. Latent class analysis was employed to characterize older adult driving self-regulation classes using driving frequency and avoidance of seven driving situations. Logistic regression was used to explore associations between characteristics affecting mobility and self-regulation class. **Results:** Three classes were identified (low, medium, and high self-regulation). High self-regulating participants reported the highest proportion of always avoiding seven risky driving situations and the lowest driving frequency followed by medium and low self-regulators. Those who were female, aged 80 years or older, visually impaired, assistive device users, and those with special health needs were more likely to be high self-regulating compared with low self-regulating. **Conclusions and practical applications:** Avoidance of certain driving situations and weekly driving frequency are valid indicators for describing driving self-regulation classes in older adults. Understanding the unique characteristics and mobility limitations of each class can guide optimal transportation strategies for older adults.

- **Keywords:** Older adult; Motor vehicle; Mobility; Self-regulation; Older driver

Michael F. Ballesteros, Kevin Webb, Roderick J. McClure. *A review of CDC's Web-based Injury Statistics Query and Reporting System (WISQARS™): Planning for the future of injury surveillance.* Pages 211-215.

Introduction: The Centers for Disease Control and Prevention (CDC) developed the Web-based Injury Statistics Query and Reporting System (WISQARSTM) to meet the data needs of injury practitioners. In 2015, CDC completed a Portfolio Review of this system to inform its future development. **Methods:** Evaluation questions addressed utilization, technology and innovation, data sources, and tools and training. Data were collected through environmental scans, a review of peer-reviewed and grey literature, a web search, and stakeholder interviews. **Results:** Review findings led to specific recommendations for each evaluation question. **Response:** CDC reviewed each recommendation and initiated several enhancements that will improve the ability of injury prevention practitioners to leverage these data, better make sense of query results, and incorporate findings and key messages into prevention practices.

- **Keywords:** Injury; Violence; Surveillance; WISQARS; CDC