

Journal of Safety Research – rok 2023, Volume 86

September 2023



Dawn N. Castillo, Christine R. Schuler, Christina M. Socias-Morales, Sergey Sinelnikov. 2022 National Occupational Injury Research Symposium (NOIRS): Preventing workplace injuries in a changing world. Pages 2-4.

About NOIRS: The National Occupational Injury Research Symposium (NOIRS) is the only conference solely dedicated to occupational injury research and prevention. The 8th NOIRS, sponsored by the National Institute for Occupational Safety and Health (NIOSH) and several partners, was held on May 10–12, 2022. NOIRS was held entirely virtually in response to concerns of the COVID-19 pandemic and honoring the symposium theme “Preventing Workplace Injuries in a Changing World.” **About this Special Issue:** The intent of this issue is to highlight the breadth of high-quality presentations at NOIRS, and to make them available to those who did not participate in the conference. This issue includes three short communication articles and nine research articles. Featured research articles in this special issue span a wide variety of methods, data sources, and worker populations. They address leading and emerging causes and contributors to occupational injury in a range of industries and occupations. Concluding Remarks: We hope that this special issue provides readers with a view into some of the research presented at the 2022 NOIRS. We also hope the articles are useful for research and practice, and thinking toward the future.

- **Keywords:** Injury prevention; Safety; Occupational; Future of work; Conference; Editorial

Sarah L. Hemler, Kurt E. Beschorner. Validation of a portable shoe tread scanner to predict slip risk. Pages 5-11.

Problem: Worn shoes are an important contributor to occupational slip and fall injuries. Tools to assess worn tread are emerging; imaging tools offer the potential to assist. The aim of this study was to develop a shoe tread scanner and evaluate its effectiveness to predict slip risk. **Methods:** This study analyzed data from two previous studies in which worn or new slip-resistant shoes were donned during an unexpected slip condition. The shoe tread for each shoe was scanned using a portable scanner that utilized frustrated

total internal reflection (FTIR) technology. The shoe tread parameters of the worn region size (WRS) for worn shoes and total contact area for new shoes were measured. These parameters were then used to predict slip risk from the unexpected slip conditions. **Results:** The WRS was able to accurately predict slip risk, but the contact area was not. **Discussion:** These findings support that increased WRS on the shoe outsole is associated with worse slip outcomes. Furthermore, the tool was able to offer robust feedback across a wide range of tread designs, but the results of this study show that the tool may be more applicable for slip-resistant shoes that are worn compared to their new counterparts. **Summary:** This study shows that FTIR technology utilized in this tool may be a useful and portable method for determining slip risk for worn shoes. **Practical Applications:** This tool has the potential to be an efficient, objective, end-user tool that improves timely replacement of shoes and prevention of injuries.

- **Keywords:** Slips, trips, and falls; Frustrated total internal reflection (FTIR); Footwear; Risk assessment tools

Kaitlin C. Wingate, Stephanie Pratt, Alejandra Ramirez-Cardenas, Kyla Hagan-Haynes. *Risky driving behaviors and employer motor vehicle safety policies among U.S. oil and gas extraction workers. Pages 12-20.*

Introduction: Over half of fatal occupational injuries in the oil and gas extraction (OGE) industry are due to transportation incidents. While driving for work is common in this industry and risky driving behaviors have been identified as contributing factors to fatal crashes among OGE workers, limited information is available on the frequency of risky driving behaviors and employer policies to reduce these behaviors. **Methods:** Researchers conducted a cross-sectional survey of OGE workers in three states. Responses from 363 OGE workers who drive as a part of their work duties were analyzed to evaluate relationships between self-reported risky driving behaviors (i.e., speeding, cell phone use, and driving unbelted) and awareness of motor vehicle safety policies by their employers. **Results:** Hands-free cell phone use was the most common risky driving behavior among participants (59.8%), while a hands-free cell phone ban was the least commonly reported employer motor vehicle safety policy (34.7%). Multiple logistic regression results identified longer work and commuting hours, lack of employer motor vehicle safety policies, having ever been in a work crash, and being employed by an operator to be significantly associated with risky driving behaviors. **Conclusions:** Workers whose employers lacked motor vehicle safety policies were more likely to engage in risky driving behaviors. **Practical applications:** Results of this survey support the implementation of motor vehicle safety interventions such as bans on texting and handheld and hands-free cell phone use, speed management, and in-vehicle monitoring systems by OGE employers as well as research focusing on the effectiveness of these interventions in OGE. Additional research could examine worker driving behaviors through self-reported data in combination with objective measures.

- **Keywords:** Cell phone use; Distracted driving; Driving for work; Seat belt use; Speeding

Eva M. Shipp, Amber B. Trueblood, Hye-Chung Kum, Marcie Perez, Shubhangi Vasudeo, Nishita Sinha, Ashesh Pant, Lingtao Wu, Myunghoon Ko. *Using motor vehicle crash records for injury surveillance and research in agriculture and forestry. Pages 21-29.*

Problem: Fatal injuries in the agriculture, forestry, and fishing sector (AgFF) outweigh those across all sectors in the United States. Transportation-related injuries are among the top contributors to these fatal events. However, traditional occupational injury surveillance systems may not completely capture crashes involving farm vehicles and logging trucks, specifically nonfatal events. **Methods:** The study aimed to develop an

integrated database of AgFF-related motor-vehicle crashes for the southwest (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas) and to use these data to conduct surveillance and research. Lessons learned during the pursuit of these aims were cataloged. Activities centered around the conduct of traditional statistical and geospatial analyses of structured data fields and natural language processing of free-text crash narratives. **Results:** The structured crash data in each state include fields that allowed farm vehicles or equipment and logging trucks to be identified. The variable definitions and coding were not consistent across states but could be harmonized. All states recorded data fields pertaining to person, vehicle, and crash/environmental factors. Structured data supported the construction of crash severity models and geospatial analyses. Law enforcement provided additional details on crash causation in free-text narratives. Crash narratives contained sufficient text to support viable machine learning models for farm vehicle or equipment crashes, but not for logging truck narratives. **Discussion:** Crash records can help to fill research and surveillance gaps in AgFF in the southwest region. This supports traffic safety's evolution to the current Safe System paradigm. There is a conceptual linkage between the Safe System and Total Worker Health approaches, providing a bridge between traffic safety and occupational health. **Practical Applications:** Despite limitations, crash records can be an important component of injury surveillance for events involving AgFF vehicles. They also can be used to inform the selection and evaluation of traffic countermeasures and behavioral interventions.

- **Keywords:** "Agriculture"; "Logging"; "Occupational Injuries" or "Work-related injuries"; "Motor vehicle crashes"; "Surveillance"

Harold Gomes, Vidisha Parasram, James Collins, Christina Socias-Morales. *Time series, seasonality and trend evaluation of 7 years (2015–2021) of OSHA severe injury data. Pages 30–38.*

Problem: Employers are required to report severe work-related injuries (e.g., amputation, inpatient hospitalization, or loss of an eye), to the Occupational Safety and Health Administration (OSHA). This study examined the OSHA severe injury reports (SIRs) public microdata to understand time-related trends and patterns. **Methods:** This study included all SIRs from January 2015 to December 2021 (84 months). We employed time series decomposition models (classical additive and multiplicative, X-11, and X-13ARIMA-SEATS) to evaluate monthly seasonal effect and seasonally adjusted trend of SIRs. We developed data visuals to display trends from different models with the original data series. We compared number of daily SIRs by day of the week, and yearly trends by 2-digit NAICS and separately by 1-digit OIICS injury event. **Results:** There were a total of 70,241 SIRs in this 7 year period; ranging from 8,704 to 11,156 per year, and 600 to 1,100 per month. Seasonally adjusted trend indicated a gradual increase of SIRs over time until October 2018, then a steeper decrease until August 2020, and staying somewhat flat for the rest of the months. Seasonality indicated more SIRs were reported in the summer months (June, July, August). Daily SIRs indicated a weekday average of 34 (SD = 9) and weekend average of 11 (SD = 5). The Manufacturing and Construction industries reported the highest yearly SIRs. Contact with objects and equipment, and falls, slips, trips were the most numerous injury events associated with SIRs. **Discussion:** Although Federal OSHA SIR data do not include SIRs from state-plan jurisdictions, the data provide a timely national trend of SIR. This is the first known time series analysis of SIRs. **Practical Applications:** The findings of this study highlight the ability of researchers to use the SIRs as a timely indicator to understand occupational injury trends by specific industries and injury events.

- **Keywords:** Time Series; Trend; Seasonality; Severe Injuries; Occupational injuries

Yuan Sun, Idris Jeelani, Masoud Gheisari. *Safe human-robot collaboration in construction: A conceptual perspective*. Pages 39-51.

Introduction: Small mobile robots have become increasingly popular in the construction domain over the last few years. They are stable on rough terrains, can walk over small obstacles, climb stairs, and carry various sensors or arms to perform diverse functions and sub-tasks required to complete construction-related tasks. Saving time, improving accessibility to difficult or unsafe spaces, and reducing costs while accomplishing construction tasks are some of the benefits of using small, mobile robots in construction. However, serious concerns about new workplace hazards could arise from having mobile robots on the jobsite. Unfortunately, no study has attempted to evaluate these risks, especially in the construction domain. Therefore, there was a significant need to develop a holistic understanding of the direct and indirect risks of mobile robot applications in construction. **Method:** In this paper, we used inferential and Virtual Reality (VR) visualization techniques to: (1) construct conceptual visualizations of proximal and distant human-robot interaction within the construction context; and (2) identify potential safety challenges of robots, which were categorized into three groups: (a) physical risks, (b) attentional costs, and (c) psychological impacts. These identified safety challenges were then validated and ranked by a group of construction safety and robotic experts who had knowledge and experience using such robots in construction. **Practical Applications:** The outcomes of the study provided a detailed understanding of how robots might adversely affect workers' safety and health. The study outcomes could also be ultimately used in creating regulatory and administrative guidelines for the safe operations of small mobile robots in construction.

- **Keywords:** Construction; Safety; Collaborative robots; Human-robot interactions

Abigail Clarke-Sather, Katherine E. Schofield. *A framework for using data and collaboration to drive prevention through engineering design: Reducing injury and severity in greenhouse and nursery workers*. Pages 52-61.

Introduction: A framework of collaboration between safety professionals and design engineers was proposed that provided direction for utilizing analysis of quantitative and qualitative data to prevent worker injury. This interdisciplinary, context-steeped approach can be utilized across a variety of industries to promote risk reduction by designing equipment and processes to prevent common workplace injuries in the first place. Safety professional expertise in regional worker's compensation claims analysis (including statistical analysis on a quantitative basis and qualitative analysis of trends in written injury descriptions of circumstance) provided the starting point for identifying industries of interest for this approach. **Method:** Followed by education of design engineers on safety approaches (including hazard identification, the ANSI/ASSP Z590.3 consensus-based standard), tools such as risk assessment matrices and methods for effective on-site work observation and interviews with workers affords transfer of knowledge. Design engineers then utilize safety influenced design problem identification and goal criteria to create and select concepts for eventual detail design and prototype testing on-site. This approach was implemented in a case-study at a Midwest greenhouse industry facility site in summer of 2019. Two problem areas were identified and addressed with two unique engineering designs that were prototyped and utilized at the facility with success. **Practical Application:** This approach can apply to other industries and collaborative teams in the future to prevent worker injury by design.

- **Keywords:** Injury prevention; Worker health and safety; Workers' compensation; Risk

Jennifer Taylor, Regan Murray, Margaret Binzer, Captain Robert Borse, Andrea Davis, Victoria Gallogly, Rozhan Ghanbari, Lieutenant Diane McKinsey, Battalion Chief David Picone, Paramedic Gary Wingrove. *EMERG-ing data: Multi-city surveillance of workplace violence against EMS responders. Pages 62-79.*

Problem: Between 1980 and 2021, emergency medical services (EMS) calls experienced a 421% increase, while calls for fires declined by 55%. The more exposure, the more the opportunity for workplace violence (WPV). Due to the non-existence of a reporting system that captures physical and verbal violence, it has been difficult to quantify the degree of WPV experienced by the U.S. fire and rescue service. **Methods:** To describe WPV in three large metropolitan fire departments, an existing data system was modified. The EMERG platform was selected because it is one of the most confidential data systems available to collect exposures. **Results:** In a one-year pilot of EMERG, 126 events were reported. Verbal violence was present in 81% of all reports, with physical violence only at 19%. Patients were the most frequently reported assailant (73%). The most frequently reported injury was emotional stress (70%). Six percent of all injuries reported moderate-to-major physical injury severity, and 30% reported moderate-to-major mental injury severity. **Discussion:** Verbal violence as a contributor to first responder stress is often underestimated. This pilot shows that it can and should be captured. That mental injury severity was consistently rated higher than physical injury severity across all injuries is not surprising given the prevalence of verbal violence reported and because physical violence has emotional sequela. **Summary:** Data from the EMERG reporting system give us evidence, on a larger scale than has ever existed for the fire and rescue service, that verbal and physical violence, and the resultant emotional stress and mental injury severity, is an issue that needs further attention and resources. **Practical Applications:** In order to ensure robust surveillance, it remains likely that triangulation of multiple data sources will still be required to approximate the true burden.

- **Keywords:** Workplace violence; Injury; EMS; Occupational health

Christina Socias-Morales, Srinivas Konda, Jennifer L. Bell, Steven J. Wurzelbacher, Steven J. Naber, G. Scott Earnest, Elizabeth P. Garza, Alysha R. Meyers, Ted Scharf. *Construction industry workers' compensation injury claims due to slips, trips, and falls – Ohio, 2010–2017. Pages 80-91.*

Problem: Compared to other industries, construction workers have higher risks for serious fall injuries. This study describes the burden and circumstances surrounding injuries related to compensable slip, trip, and fall (STF) claims from private construction industries covered by the Ohio Bureau of Workers' Compensation. **Methods:** STF injury claims in the Ohio construction industry from 2010–2017 were manually reviewed. Claims were classified as: slips or trips without a fall (STWOF), falls on the same level (FSL), falls to a lower level (FLL), and other. Claim narratives were categorized by work-related risk and contributing factors. Demographic, employer, and injury characteristics were examined by fall type and claim type (medical-only (MO, 0–7 days away from work, DAFW) or lost-time (LT, ≥8 DAFW)). Claim rates per 10,000 estimated full-time equivalent employees (FTEs) were calculated. **Results:** 9,517 Ohio construction industry STF claims occurred during the 8-year period, with an average annual rate of 75 claims per 10,000 FTEs. The rate of STFs decreased by 37% from 2010 to 2017. About half of the claims were FLL (51%), 29% were FSL, 17% were STWOF, and 3% were "other." Nearly 40% of all STF claims were LT; mostly among males (96%). The top three contributing factors for STWOF and FSL were: slip/trip hazards, floor irregularities, and ice/snow; and ladders, vehicles, and stairs/steps for FLL. FLL injury rates per 10,000 FTE were highest in these industries: Foundation, Structure, and Building Exterior Contractors (52); Building Finishing Contractors (45); and Residential Building Construction (45). The

highest rate of FLL LT claims occurred in the smallest firms, and the FLL rate decreased as construction firm size increased. Discussion and **Practical Applications:** STF rates declined over time, yet remain common, requiring prevention activities. Safety professionals should focus on contributing factors when developing prevention strategies, especially high-risk subsectors and small firms.

- **Keywords:** Construction workers; Workers' compensation claims; Occupational injuries or Work-related injuries; Slips, trips, or falls

Jennifer M. Lincoln, K.C. Elliott. *Emerging technology in agriculture: Opportunities and considerations for occupational safety and health researchers.* Pages 92-95.

Introduction: A variety of factors are driving the development of robotics and automation in the agriculture industry including the nature of work, workforce shortages, and a variety of economic, climatic, technologic, political, and social factors. While some new robotics and automated machines are available commercially, most are still being developed. This provides occupational safety and health researchers an unprecedented opportunity to mitigate risks and benefit the health and safety of agriculture workers.

Method: The NIOSH Office of Agriculture Safety and Health (OASH) is working to better understand how the advancements in automation and robotics is affecting workers. OASH is coordinating with the NIOSH Center of Occupational Robotics Research (CORR) to help to increase the understanding of human/machine interactions; improve the ability to identify injuries and fatalities involving automation/ robotics; and provide guidance on working safely with automation/ robotics. OASH also joined a small team of academics and industry to organize the SAFETY For Emerging Robotics and Autonomous Agriculture or (SAFER AG) Workshop to identify gaps in knowledge and research needs that connect to issues related to risks and regulations/standards, occupational safety research, and impacts on workforce and society. This workshop was sponsored by USDA NIFA.

Practical Applications: Occupational safety and health experts need to engage and collaborate with developers of technology. It is also increasingly important for occupational safety and health researchers and practitioners to not only become familiar with existing manufacturing safety standards, but also the lengthy standards development process. Joining consensus standards groups to help shape new standards for emerging technologies may help to mitigate adverse worker impacts. NIOSH's Office of Agriculture Safety and Health will continue to identify research gaps, support new research projects, education, outreach efforts and the development of best practices with our partners.

- **Keywords:** Robotics; Automation; Agriculture

Ron Gantt. *Does occupational injury research illuminate or obscure occupational safety?* Pages 96-99.

Introduction: The effectiveness of occupational injury research may, at least in part, depend upon the perspective used in that research. **Method:** This paper presents two perspectives occupational injury research may adopt – the injury-focused and the occupation-focused perspectives. The injury-focused perspective sees injuries as the primary unit of analysis in occupational injury research. It is based on several premises that focus its research on understanding occupational injuries. However, this focus may obscure certain factors of how injuries occur and, ultimately, how to create occupational safety. By contrast, the occupation-focused perspective sees work as the primary unit of analysis of occupational injury research. This perspective may allow researchers to solve what is described in this paper as the 'dark safety' problem (i.e., how even unsafe systems go long periods of time without failure). The paper does not argue that one or the other perspective should be the only perspective. However, a balanced perspective

between injury-focused and occupation-focused research is needed to further occupational injury research.

- **Keywords:** Occupational injury research; Occupational safety; Research methods; Research effectiveness; Research perspectives

Richard Olawoyin, Jack Ogutu. *The future of the U.S. safety & health workforce: Opportunities for academic diversity, equity, and inclusion through a leak-proof career pathway.* Pages 100-106.

Introduction: In this commentary, we explore safety and health career pathways in the U.S. and discuss the future of work through the lens of diversity, equity, and inclusion. We address occupational safety and health inequities, including underrepresentation of racial and ethnic groups in academic disciplines, which impacts workers' safety and the future of work. We introduce the Accessibility, Sustainability, and Knowledge-Generation (ASK) framework to broaden minority participation in occupational safety and health (OSH) education. **Method:** The ASK framework integrates insights from learned experiences, research literature, accreditation knowledge, and community feedback to identify strategies for dismantling barriers to workforce diversity and promoting equitable participation and access to opportunities in OSH education. We conducted a US based survey to gain insights into the minority experience and the role of students, faculty, and academia in mitigating disparities and creating pathways of opportunities. **Results:** The survey results highlight the need for pedagogic improvements in OSH academic programs to attract more minorities. The appreciation of cultural competence across universities and changes to current systemic funding mechanisms are identified as crucial factors. We acknowledge that existing interventions have been less effective due to a lack of tangible actions. However, we emphasize that solutions exist, and meaningful support is required to drive change. **Conclusions:** The study underscores the importance of addressing occupational safety and health inequities and the underrepresentation of minority groups in OSH education. The ASK framework provides a comprehensive approach to broaden minority participation and promote diversity in the field. Pedagogic improvements, cultural competence, and changes to funding mechanisms are necessary steps to attract and retain underrepresented minorities in OSH academic programs. **Practical Applications:** The findings of this study have practical implications for institutions and stakeholders involved in occupational safety and health education. It emphasizes the need for proactive strategies to attract and support underrepresented minority students and faculty. Promoting cultural competence and making changes to funding mechanisms can contribute to creating more equitable and inclusive pathways for diverse groups in OSH education. Tangible actions and meaningful support are essential for driving change and achieving workforce diversity and equity.

- **Keywords:** Occupational safety and health equity; Diverse workforce; Underrepresented minority; ASK framework; Career pathway; Inclusion

Wonil Lee, Jia-Hua Lin, Ninica Howard, Stephen Bao. *Physiological responses, trunk posture, and work pace in commercial building cleaning in Washington State: an observational field study.* Pages 107-117.

Introduction: This study aimed to investigate whether work pace is a critical indicator for predicting a janitor's risk of work-related musculoskeletal disorders (WMSDs). **Method:** Field measurements were obtained from commercial building janitors as well as the determination of work pace. Physiological responses collected were heart rate, energy expenditure (calories), activity level (METs), steps, trunk posture. Data were obtained using direct measurements, along with a time study, which was performed by shadowing 13 janitors in Washington State. The measured values were summarized descriptively, and five of the most common janitorial tasks were compared. The relationships between work pace and the physiological response variables were

determined by calculating the Pearson product-moment correlation coefficients. **Results:** The highest average percent heart rate reserve (47.4%) was reported during restroom cleaning, while the highest activity and energy expenditure levels (3.6 METs and 217.1 calories/h) were reported for mopping. The top 90% of trunk flexion angles and the highest percentage of time in trunk flexion from 20° to 60° were recorded during restroom cleaning. Restroom cleaning showed the highest correlation between all the physiological response variables and work pace. In most of the tasks, a high work pace may have increased the degree and duration of severe trunk flexion. **Conclusion:** Overall, when several tasks were considered, the extent of physiological responses, trunk joint angles, and exposure time to awkward postures tended to increase with an increase in work pace. **Practical Applications:** This study showed the feasibility of using the work pace measured from time studies as a predictive indicator of WMSDs risks. Using this information, managers may compose a schedule that can minimize WMSDs risks while considering actual work pace deviations that may impact a janitor's ability to complete assigned tasks properly within a shift.

- **Keywords:** Physiological responses; Trunk posture; Work pace; Time study; Work-related Musculoskeletal Disorders

Sabrina Santiago Oliveira, Willames de Albuquerque Soares, Bianca M. Vasconcelos. *Fatal fall-from-height accidents: Statistical treatment using the Human Factors Analysis and Classification System – HFACS. Pages 118-126.*

Introduction: The civil construction industry (CCI) is one of the most dangerous sectors for occupational accidents. Studies conducted in several countries show that occupational accidents involving falls from height are the main cause of deaths in recent years. **Method:** This article analyzed the combinations of causal factors with the highest likelihood of accidents involving falls from height in construction to assist in decision-making. The methodology was divided into four stages: accident collection and sample definition; accident analysis; probability determination; and obtaining the theoretical curve of an accident probability distribution. The methodology was applied to reports of fatal fall-from-height accidents that occurred in the United States between 1997 and 2020. **Results:** The results show that among the accidents analyzed, the highest probability of fatality is when a roofer aged between 31 and 44 years performs their activity on a roof between 10:00 and 11:59 am. It is also noted that the three causal factors most present in the accidents were: organizational process (97.7%); poor management of worker resources (96.6%); and organizational climate (95.4%). From the probability distribution curve, 68% of the fatal accidents occurred after reaching between 18 and 34 causal factors present in the HFACS method categories.

- **Keywords:** Occupational accident; Fatality; Construction; Cause; Construction safety

Ian J. Reagan, Jessica B. Cicchino, Eric R. Teoh, Aimee E. Cox. *The association between strengthened cellphone laws and police-reported rear-end crash rates. Pages 127-136.*

Introduction: Prior evaluations of the connection between cellphone bans and crashes show unclear results. California, Oregon, and Washington enacted legislation (effective in 2017) to update earlier bans specific to handheld conversation and texting. This study evaluated the relationship between the laws and rear-end rates, a crash type sensitive to visual-manual cellphone use, in California, Oregon, and Washington. **Method:** Negative binomial regression compared the change in monthly per capita rear-end crash rates in California, Oregon, and Washington before and after the law changes relative to two control states, Colorado and Idaho, during 2015–2019. Analyses examined (a) rear-end

crashes with injuries in all three study states, including minor to fatal injuries; and (b) rear-end crashes of all severities in California and Washington, including property-damage-only crashes and crashes with injuries; Oregon was excluded from this analysis because of a 2018 change to its reporting criteria for property-damage-only crashes.

Results: Washington's strengthened law was associated with a significant 7.6% reduction in the rate of monthly rear-end crashes of all severities relative to the controls. Law changes in Oregon and Washington were associated with significant reductions of 8.8% and 10.9%, respectively, in the rates of monthly rear-end crashes with injury relative to the controls. California did not experience changes in rear-end crash rates of all severities or with injuries associated with the strengthened law. **Conclusion:** The results of this study are mixed, with law changes associated with significant reductions in rear-end crash rates in two of the three study states. Differences in the wording of the laws, levels of enforcement, and sanction severity may help explain the divergent results.

Practical application: Crash reductions in Oregon and Washington suggest that enacting legislation that comprehensively bans practically all visual-manual cellphone activity may have made the laws easier to enforce and clarified to drivers that handheld cellphone use is unacceptable in these states.

- **Keywords:** Distraction driving; Strengthened cellphone laws; Visual distraction; Rear-end crash rate

Hannah Younes, Robert B. Noland, Leigh Ann Von Hagen, Sean Meehan. *Pedestrian- and bicyclist-involved crashes: Associations with spatial factors, pedestrian infrastructure, and equity impacts. Pages 137-147.*

Introduction: We analyze and compare the factors that influence the fatality of pedestrian and bicyclist involved crashes in New Jersey using available police-reported crash data between 2016 and 2020. Under three percent of crashes involve non-motorists statewide, but these account for about one third of all traffic fatalities in the state. **Methods:** Our analysis is broken down into five parts: we (1) analyze the relationship between minority and low-income communities and non-motorist involved crashes; (2) identify spatial differences between non-motorist involved crashes and non-motorist involved fatal crashes; (3) compare the factors affecting fatal pedestrian crashes in New Jersey and in four counties in southern New Jersey for which we have data on pedestrian infrastructure; (4) compare the factors affecting fatal pedestrian crashes and fatal cyclist crashes in New Jersey; and, (5) discuss priority areas for improving safety.

Results: Crashes occur disproportionately more often in low-income communities. Moreover, we find that crashes are less likely to be geocoded if they take place in low-income and minority areas, a concerning finding considering that geocoded crashes are of paramount importance in identifying specific corridors for improvement. Light conditions, non-motorist age, posted speed, and vehicle type are significant factors influencing the fatality of non-motorist involved crashes. The proximity to a crosswalk or sidewalk is associated with decreased risk of a fatal crash for pedestrians. Cyclist crashes in low-income neighborhoods were more likely to be fatal – a finding that we attribute to lower access to bicycle facilities in low-income areas. **Conclusions:** We conclude with countermeasures, including a call for better data collection.

- **Keywords:** Fatal Crashes; Pedestrians; Cyclists; Low-income; Minorities

Hengyan Pan, Haijing He, Yonggang Wang, Yanqiu Cheng, Zhe Dai. *The impact of non-driving related tasks on the development of driver sleepiness and takeover performances in prolonged automated driving. Pages 148-163.*

Introduction: Vehicle automation is thought to improve road safety since numerous accidents are caused by human error. However, the lack of active involvement and

monotonous driving environments due to automation may contribute to drivers' passive fatigue and sleepiness. Previous research indicated that non-driving related tasks (NDRTs) were beneficial in maintaining drivers' arousal levels but detrimental to takeover performance. **Method:** A 3·2 mixed design (between subjects: driving condition; within subjects: takeover orders) simulator experiment was conducted to explore the development of driver sleepiness in prolonged automated driving context and the effect of NDRTs on driver sleepiness development, and to further evaluate the impact of driver sleepiness and NDRTs on takeover performance. Sixty-three participants were randomly assigned to three driving conditions, each lasting 60 min: automated driving while performing driving environment monitoring task; visual NDRTs task; and visual NDRTs with scheduled driving environment monitoring task. Two hazardous events occurring at about the 5th and 55th min needed to be handled during the respective driving. **Results:** Drivers performing monitoring tasks had a faster development of driver sleepiness than drivers in the other two conditions in terms of both subjective and objective indicators. Takeover performance of drivers performing monitoring task were undermined due to driver sleepiness in terms of braking and steering reaction times, the time between saccade latency and braking or steering reaction times, and so forth. Additionally, NDRTs impaired the drivers' takeover ability in terms of saccade latency, max braking pedal input, max steering velocity, minimum time to collision, and so forth. This study shows that NDRTs with scheduled road environment monitoring task improve takeover performance during prolonged automated driving by helping to maintain driver alertness. **Practical Applications:** Findings from this work provide some technical assistance in the development of driver sleepiness monitoring systems for conditionally automated vehicles.

- **Keywords:** Prolonged automated driving; Driver sleepiness; Non-driving related tasks; Takeover performances

Lynn Meuleners, Michelle Fraser, Mark Stevenson, Paul Roberts.
Personalized driving safety: Using telematics to reduce risky driving behavior among young drivers. Pages 164-173.

Introduction: The role of real-time data capture (via telematics technology) is gathering prominence as a strategy to provide feedback to young drivers about important road safety issues. **Method:** A naturalistic driving study was undertaken to determine whether providing personalized feedback (via a smartphone app) to young provisional drivers aged 17–20 years living in metropolitan and regional Western Australia (WA) reduced their risky driving behavior compared to a control group who did not receive feedback. Speeding over the posted speed limit, harsh decelerations (braking), harsh accelerations and overall driving performance, were recorded continuously using the smartphone app during the 11-week study. Four separate Generalised Estimating Equations (GEE) linear regression models were undertaken after accounting for relevant confounders including driving exposure to determine the difference between the intervention and control group for the 4 driving outcomes obtained from the smartphone app. **Results:** The study found that there was no significant change in overall driving scores between the intervention and control groups ($p = 0.35$). However, the overall driving score significantly improved by 0.19 points for young provisional drivers who lived in regional areas compared to those in the metropolitan area ($p = 0.05$) after adjusting for potential confounders. There was also no significant change in harsh braking scores ($p = 0.46$) and harsh acceleration scores between the intervention and control groups ($p = 0.26$). However, harsh acceleration scores improved by 0.37 points for females compared to males ($p = 0.04$). Lastly, there was no significant change in speed scores between the control and intervention groups ($p = 0.72$). However, the speed scores of participants who lived in regional WA improved by 0.22 points compared to those in the metropolitan area ($p = 0.02$). Furthermore, for every 1,000 km travelled, speed scores worsened by -0.08 points ($p < 0.01$) regardless of group. **Conclusions:** The study did not find any statistical difference in the driving outcomes examined; however the treatment effects for feedback

were consistently in the expected positive direction. Young drivers in regional WA also improved their speeding scores and overall driving performance scores compared to young drivers in the metropolitan area. Females, also significantly improved their harsh deceleration scores compared to males, regardless of group allocation. These results highlight the use of smartphone telematics as an opportunity to not only enhance the safety of provisional young drivers but also provide data-informed decision making and policy development.

- **Keywords:** Young drivers; Road safety; Telematics; Personalized feedback; Naturalistic study

Gro Ellen Mathisen, Tore Tjora. *Safety voice climate: A psychometric evaluation and validation.* Pages 174-184.

Introduction: Speaking up about safety issues, termed “safety voice,” is a proactive response where people across all levels of the organization express their concerns to prevent physical hazards. An understanding of safety voice requires insight into its antecedents. A perceived need to fit in with the organization and fear of consequences can trump the courage to speak out about safety concerns. Safety voice climate can be seen as a manifestation of the social exchanges in an organization and functions as a roadmap of which speaking out behaviors are encouraged and which behaviors are not. This study conceptualizes safety voice climate, presents the Safety Voice Climate Scale (SVCS) as a measurement tool, and gathers initial evidence for its validity. The study also assesses the associations between the SVCS and safety voice behavior. **Method:** The SVCS and the measurement of safety voice behavior were derived from the Trends in Risk Level in the Norwegian Petroleum Activity questionnaire. The SVCS includes the two theoretical dimensions Work colleagues’ encouragement of safety voice and Leaders’ attitudes towards safety voice. Psychometric properties were tested with a representative sample from the Norwegian petroleum sector (n = 7,624). **Results:** Confirmatory factor analyses supported the proposed two-factor model, and the internal consistency of the factors was good. Furthermore, a structural equation model including the SVCS as predictors of safety voice behavior showed a good fit, indicating acceptable criterion validity, although only the Work colleagues’ encouragement of safety voice variable was significantly associated with safety voice behavior. **Conclusion and practical application:** The SVCS can be used as a tool to detect some of the barriers and supporting elements relating to safety voice and guidance on the efforts needed to foster work climates that promote communication of safety issues.

- **Keywords:** Safety voice; Safety lead indicator; Leadership; Safety climate; High-risk industry; Safety culture

Elizabeth E. O'Neal, Linder Wendt, Cara Hamann, Michelle Reyes, Jingzhen Yang, Corinne Peek-Asa. *Rates and predictors of teen driver crash culpability.* Pages 185-190.

Background: Motor-vehicle crash risk is highest among teen drivers. Despite a wealth of research on the topic, there are still many contributors to these crashes that are not well understood. The current study sought to examine the contribution of graduated driver licensing (GDL) restrictions, sex, age, roadway circumstances, and citation history to teen drivers’ crash culpability. **Method:** Crash system data from the Iowa Department of Transportation were linked with traffic-related charges from the Iowa Court Information System. Crashes involving teens aged 14 to 17 years between 2016 and 2019 were analyzed (N = 19,847). Culpability was determined using the driver contributing circumstances from the crash report. Moving and non-moving traffic citations issued prior to the date of each crash were considered. A multivariable logistic regression model was constructed to examine predictors of crash culpability. **Results:** Teen drivers were determined to be culpable for more than two thirds of crashes (N = 13,604, 68.54%).

Culpability was more prevalent among males, younger teens, in rural areas, in the presence of reported roadway contributing circumstances, during hours of restricted nighttime driving, and among teens with citation histories that included both moving and non-moving citations. Similarly, multivariable model results indicated that the likelihood of culpability was higher among males, in rural areas, and at each stage of GDL compared to teen drivers with unrestricted licenses. While drivers with a history of both moving and non-moving violations were more likely to be culpable, those with a history of only moving or only non-moving violations were less likely to be culpable compared to those with no violation history. **Conclusion:** Sex, crash location, and GDL stage were associated with teen driver crash culpability. A singular prior moving or non-moving violation may play a protective role in teen crash culpability.

- **Keywords:** Novice teen drivers; Crash culpability; Graduated drivers licensing

Lu Ling, Wenbo Zhang, Jie Bao, Satish V. Ukkusuri. *Influencing factors for right turn lane crash frequency based on geographically and temporally weighted regression models. Pages 191-208.*

Introduction: Right-turn lane (RTL) crashes are among the key contributors to intersection crashes in the US. Unfortunately, the lack of deep insights into understanding the effects of RTL geometric design factors on crash frequency impedes improving RTL safety performance. **Method:** Taking the crash data in ten counties in Indiana state from 2013 to 2016 as a case study, this study investigates the safety performance of RTL geometric configuration based on multi-sources. We introduce the geographically and temporally weighted negative binomial model (GTWNBR) to capture the space and time instability in crashes. **Results:** The results show that the impacts of RTL geometric design factors on crash frequency vary significantly among space and time. Several key insights can be obtained from the state-wide and multi-years crash analysis by associating the estimated parameters with road classes, localities, and counties. **Conclusions:** First, the RTL's length, width, turning radius, and the installments of traffic roundabouts present higher spatiotemporal heterogeneity than other factors in modeling the crash frequency. Second, the effects of RTL's geometric factors vary significantly across space and time. The presence of bicycle and pedestrian lanes is more likely to increase crashes in urban areas than in rural ones, especially at nighttime. Third, while exclusive RTLs decrease the crash frequency compared to the shared RTLs, the exclusive RTLs are more likely to increase the crashes for RTLs on the county road than on other road classes. Increasing RTL's turning radius and decreasing RTL's length is more likely to promote crashes for RTLs on county roads than on other road classes. **Practical Applications:** The insights provide vital guidance to improve the safety performance of geometric configuration for RTLs and intersections.

- **Keywords:** Right turn lane; Geometric design; Crash frequency; Spatiotemporal effects; Geographically temporally weighted negative binomial regression

Kerry A. Howard, Sarah F. Griffin, Mackenzie Stuenkel, Kerry K. Sease. *Community features' varying insight into emergency department use for different childhood injuries. Pages 209-212.*

Background: Community-level factors, including poverty level, minority population, and rurality are predictive of child injury rates. Community-based interventions targeting high-risk communities have been suggested for prevention and are reliant on understanding details of the community and prevalent types of injuries. The present study assessed injury rates based on characteristics of the community and for different types of injuries. **Method:** A retrospective review of emergency department visits identified zip-code and injury type data for children 0–19. Injuries related to bicycles, falls, motor-vehicle traffic (MTV), and violence were examined. Poverty level, minority population, rural classification, and insured population were obtained at the zip-code

level. Regression models examined the association between community features and injury rates for the four categories of injuries. **Results:** The results showed that the relationship between community features and injury rates was dependent on injury type. Rurality was associated with a lower rate for bicycle and falls, but a higher rate of MVT; higher insured population was associated with higher MVT and violence rates; higher minority population was associated with lower rates for falls and MTV; and higher population in poverty was associated with lower rate for MTV. **Conclusions:** The findings indicate that injury rates not only cluster among community-level characteristics, but also the type of injury. Variation in community features and injury types offer insight into a holistic approach to child health. **Practical Applications:** In addition to other factors related to risk for injuries, health providers' knowledge of features of the local community and prevalent injuries in the environment may be helpful additions to programming geared toward lessening the burden of injuries on children and healthcare systems.

- **Keywords:** Injury prevention; Community health; Childhood injury; Child safety; Injury types

Jason Kearney, Carlyn Muir, Karen Smith, Ben Meadley. *Exploring factors associated with paramedic work-related psychological injury through data linkage. Pages 213-225.*

Introduction: In comparison to the general population and other emergency services workers, paramedics experience high rates of work-related psychological injury. However, there is limited understanding of the case and practitioner-related factors that increase the risk of psychological injury among these workers. This paper aims to identify case and practitioner-related factors associated with paramedic work-related psychological injury in Victoria, Australia, through data linkage. **Methods:** Data linkage of 7,223 paramedic injury reports with electronic patient care records, and paramedic demographic data from the single state-wide ambulance service in Victoria, Australia – Ambulance Victoria. Injuries reported between 1 January 2015 and 30 June 2020 were included. Factors associated with paramedic psychological injury were assessed using multivariable logistic regression analysis. **Results:** A total of 4,641 (64%) injury reports were successfully linked, of which, 244 (5%) were psychological injuries. Shift hours between 0401 and 0800 (AOR 1.83; 95%CI: 1.12–2.97), cardiac arrest or deceased patient attendances (AOR 2.15; 95%CI: 1.06–4.34), hospital or medical center case locations (AOR 2.44; 95%CI: 1.22–4.91), and Priority 0 (AOR 2.27; 95%CI: 1.26–4.09), Priority 2 (AOR 1.56; 95%CI: 1.04–2.33), and Priority 3 (AOR 1.95; 95%CI: 1.15–3.32) dispatch codes were associated with increased odds of psychological injury. Increasing patient age (AOR 0.98; 95%CI: 0.97–0.99), and the absence of other emergency services on scene (AOR 0.50; 95%CI: 0.34–0.72) were associated with decreased odds of paramedic psychological injury. **Conclusions:** This is the first study to collectively examine and identify EMS case and practitioner-related characteristics associated with paramedic psychological injury through data linkage of EMS agency-level data sources. **Practical application:** The findings of this study highlight the dispatch case characteristics that may increase the risk of a paramedic sustaining a work-related psychological injury, and consequently facilitate the early identification, intervention, and support of the individuals most at risk.

- **Keywords:** Occupational injuries; Occupational safety; Emergency medical services; Mental health; Ambulance

Prince Ewudzie Quansah, Yongyue Zhu, Minyu Guo. *Assessing the effects of safety leadership, employee engagement, and psychological safety on safety performance. Pages 226-244.*

Introduction: The study assessed the impact mechanisms of employee engagement and psychological safety in safety leadership and safety performance relationships. **Method:**

We collected 539 valid responses from contract miners using a multi-wave survey research design. We analyzed the data quantitatively using the structural equation model (SEM) and hierarchical regression analysis (HRA) in AMOS and SPSS version 26 software. We used SEM to examine our proposed framework's main and structural mediation effects. HRA was used to test the moderation effect of our framework. **Results:** From the SEM results of our study, safety leadership significantly and positively influenced all two dimensions of safety performance-safety compliance and safety participation -- and all three dimensions of employee engagement-vigor, dedication, and absorption. Also, vigor, dedication, and absorption partially mediated the relationship between safety leadership and safety compliance, but fully mediated the safety leadership-safety participation relationship. From the HRA results, psychological safety significantly moderated two employee engagement variables (thus, vigor and dedication) and safety compliance. Also, it moderated all three variables of employee engagement (vigor, dedication, and absorption) and safety participation. **Practical Applications:** This current study highlights the importance of examining safety leadership on specific job performance, such as safety performance. It also highlights the necessity of having psychological safety and enhancing employee engagement in the mines.

- **Keywords:** Safety leadership; Employee engagement; Safety performance; Psychological safety

Avital R. Wulz, J. Danielle Sharpe, Gabrielle F. Miller, Amy F. Wolkin.
Association between social vulnerability factors and unintentional fatal injury rates – United States, 2015–2019. Pages 245-252.

Background: Differences in social and environmental factors can contribute to disparities in fatal injury rates. The purpose of this study was to examine the relationship between social and environmental factors and unintentional fatal injury across counties in the United States and how this relationship varies by geography. **Methods:** County-level vital statistics on age-adjusted unintentional fatal injury rates for 2015–2019 were linked with county-level data from the 2018 Social Vulnerability Index (SVI), a dataset identifying socially vulnerable communities. We conducted linear regression to examine the association between SVI and unintentional fatal injury, overall and by Census region/division. We mapped county-level data for SVI and unintentional fatal injury rates in bivariate choropleth maps using quartiles. **Results:** SVI was positively associated with unintentional fatal injury ($\beta = 18.29$, $p < 0.001$) across U.S. counties. The geographic distribution of SVI and unintentional fatal injury rates varied spatially and substantially for U.S. counties, with counties in the South and West regions having the greatest levels of SVI and rates of unintentional fatal injury. **Conclusions:** Our findings demonstrate that the social vulnerability of counties is associated with unintentional fatal injury rates. Modification of the SVI for injury research could include additional social determinants and exclude variables not applicable to injuries. A modified SVI could inform unintentional injury prevention strategies by prioritizing efforts in areas with high levels of social vulnerability. **Practical Applications:** This study is the first step in combining the SVI and injury mortality data to provide researchers with an index to investigate upstream factors related to injury.

- **Keywords:** Social vulnerability; Disparities; Health equity; Injury prevention; Social determinants of health

Qianwen Li, Zhenyu Wang, Rama Durga Tammayya Naidu Kolla, Mingchen Li, Runan Yang, Pei-Sung Lin, Xiaopeng Li. *Modeling effects of roadway lighting photometric criteria on nighttime pedestrian crashes on roadway segments. Pages 253-261.*

Introduction: Nighttime crashes account for 74% of pedestrian fatalities in the United States, and reduced visibility is a significant cause of nighttime pedestrian crashes. Maintaining sufficient and uniform roadway lighting is an effective countermeasure to improve pedestrian visibility and prevent nighttime pedestrian crashes and injuries. Previous studies have not quantified the safety effects of roadway photometric patterns (i.e., average lighting level and uniformity) on nighttime pedestrian crashes on roadway segments. **Method:** This study investigated the association between two roadway photometric criteria (horizontal illuminance mean representing average lighting level and horizontal illuminance standard deviation representing lighting uniformity) and nighttime pedestrian crash occurrence in Florida roadway segments. The matched case-control method was used to decouple the confounding effects between the illuminance mean and standard deviation. Statistically-significant crash modification factors (CMFs) were developed to quantify the safety effects of the mean and standard deviation of horizontal illuminance on nighttime pedestrian crashes. **Results:** The results show that if the average lighting level on a roadway segment is increased from a low illuminance mean (<0.2 foot-candle [fc]) to a medium illuminance mean [0.2 fc, 0.5 fc], a medium-high illuminance mean (0.5 fc, 1.0 fc), and a high illuminance mean (>1.0 fc), the relative likelihood of nighttime pedestrian crashes on midblock segments in Florida tends to be reduced by 77.5% (CMF=0.225), 81.2% (CMF=0.188), and 85.5% (CMF=0.145), respectively. **Practical Applications:** A poor uniformity (illuminance standard deviation ≥ 0.52 fc) is likely to increase the relative likelihood of nighttime pedestrian crashes on midblock segments in Florida by 80.3% (CMF=1.803) compared to good uniformity (illuminance standard deviation < 0.52 fc).

- **Keywords:** Street lighting; Nighttime pedestrian crash; Crash modification factor; CMF; Matched case-control study; Horizontal illuminance

Angela Batson, Sharon Newnam, Sjaan Koppel. *A preliminary study on the barriers and facilitators to improving the health, safety, and well-being of aging heavy vehicle drivers. Pages 262-273.*

Introduction. Managers from road freight transportation organizations were interviewed on barriers and facilitators to implementation of occupational health, safety, and well-being interventions for aging heavy vehicle drivers. As aging drivers are more likely to be seriously injured or die in a work-related incident than younger drivers, it is important to recognize strengths and weaknesses throughout the system to identify intervention that addresses their specific needs. **Method:** A Systems Theoretic Accident Model and Processes (STAMP) control structure was constructed to chart the controllers, controls, and feedback channels in the system to identify gaps in health, safety, and well-being intervention in the system. The STAMP control structure also charted the barriers and facilitators within levels across the system. Eleven managers were recruited into the study representing a range of road freight transportation organizations throughout Australia. **Results:** Interview data revealed that barriers and facilitators existed at most levels of the system. Facilitators included advice from external agencies, support from upper management, modern technology, and regular social communication with drivers. Barriers were a lack of guidance on aging issues, operational conflicts with health and safety objectives, and the drivers' fear of disclosing health information associated with their driving role. In regards to formalized intervention in place to support aging heavy vehicle drivers, the system is reliant on fitness to drive medical assessments based on age and jurisdiction. **Conclusions:** As there was generally a lack of senior direction cited from the upper levels of the system on aging issues, there was much variation across the

study on how aging risks are managed in the workplace for heavy vehicle drivers. **Practical Applications:** This study recommends that managers across the road freight transportation industry receive formalized aging-awareness health and safety training in how to manage work-related driving hazards for aging heavy vehicle drivers.

- **Keywords:** Road freight transportation industry; Heavy vehicle driver; Ageing driver; Occupational health and safety; STAMP control structure

Clément Laverdet, Pascal Malola, Thierry Meyer, Patricia Delhomme. *Electric personal mobility device driver behaviors, their antecedents and consequences: A narrative review. Pages 274-285.*

Introduction: Electric personal mobility devices (ePMDs), as well as crashes involving ePMDs, have been on the rise all over the world. The objectives of this study were: (a) to summarize the literature based on a narrow definition of ePMD (excluding e-bikes) and (b) to sort out the results to fit into a psychological and behavioral framework. The available literature was sorted into three main categories: the behaviors of ePMD drivers, their antecedents, and their consequences. **Method:** A narrative review of the literature was carried out in 101 documents published between January 2018 and July 2021. **Results:** Regarding behavioral antecedents, regulations vary from country to country. ePMDs were found to be used primarily by males under 40 years of age. We found no studies on driving skills or learning, driver education or training, or on the effect of health messages on attitudes and behavior. Regarding the main behaviors themselves, the drivers' reasons for focusing on ePMDs were our main focus (use for short distances and mainly for commuting, shopping, and leisure). Few of the studies we reviewed explored the interactions between ePMD drivers and other road users in natural or simulated environments, and the influence of road infrastructure on behavior has rarely been studied. Regarding health consequences, reported ePMD crashes resulted in serious head and limb injuries, especially head and leg fractures. The lack of personal protective equipment (e.g., a helmet) increased the severity of crashes. The conclusion highlights gaps in the literature from a psychological and behavioral point of view.

- **Keywords:** Electric personal mobility devices; Crashes; Road safety; Public policy; Driving behavior

Charmaine Mullins-Jaime, Todd D. Smith. *Interconnected pathways: The role of integrated programs, safety climate, and safety professional engagement in safety and other organizational outcomes. Pages 286-297.*

Background: This study evaluated interconnected pathways of the use of safety management systems (SMS), environmental management systems (EMS), Lean, participatory programs, and integrated systems and their effect on safety management and other organizational outcomes from the perspective of safety professionals working within complex work systems. **Method:** Data were collected from 136 safety professionals. A structural path analysis assessed direct and indirect effects within the model and a confirmatory factor analysis evaluated high impact risk management practices and safety incidents as a model to assess safety management outcomes. **Results:** SMS implementation had significant direct effects on safety climate and high impact risk management practices. EMS implementation had significant direct effects on environmental management outcomes. Integration of SMS and EMS with Lean had significant direct effects on safety climate and safety professional engagement. Participatory programs had significant direct effects on high impact risk management practices and safety incidents. Safety professional engagement and safety climate had significant mediating effects on safety and organizational outcomes as did the use of high impact risk management practices. **Conclusion:** Results of this study present a case for

the use of high impact risk management practices and safety incidents as a measurement of safety management outcomes and the use of participatory programs, SMS, and integrated systems, driven by highly engaged individuals to influence safety and organizational outcomes.

- **Keywords:** Safety management systems; Safety climate; Risk management practices; Safety metrics; Safety professional engagement

Umair Durrani, Chris Lee. *Applying the Accumulator model to predict driver's reaction time based on looming in approaching and braking conditions. Pages 298-310.*

Introduction: The prediction of when the driver will react to a change in the lead vehicle motion is critical for assessing rear-end crash risk using car-following models. Past studies have assumed constant reaction time and driver's continuous reaction. However, these assumptions are not valid as the driver's reaction time can vary in different car-following situations and the driver does not continuously react to the lead vehicle motion. Thus, this study predicted the driver's reaction time using the Wiedemann car-following model and the Accumulator model. The Accumulator model assumes the driver's start of reaction based on the accumulation of looming and thereby reflects the driver's intermittent reaction. **Method:** Fifty drivers' behavior was observed using a driving simulator in two scenarios: (1) approach and follow a moving lead vehicle and (2) approach a stopped lead vehicle. The Accumulator model predicted the reaction times based on different looming variables (angular velocity and tau-inverse), lead vehicle type (car and truck), and lead vehicle brake lights (on or off). **Results:** The Accumulator model showed lower prediction errors of the reaction time than the Wiedemann model, which assumes reaction based on the fixed looming threshold. The Accumulator model predicted the reaction times more accurately when it was calibrated with the angular velocity due to width and height of lead vehicles. Moreover, the Accumulator model with tau-inverse produced the smallest prediction error of reaction times among different Accumulator models and the Wiedemann model when lead vehicle brake lights were on. **Conclusions:** This study demonstrates that the Accumulator model is a promising method of predicting the driver's reaction time in car-following situations, which affects rear-end crash risk. **Practical Applications:** The Accumulator model can be incorporated into a car-following model for the prediction of reaction times and can estimate the rear-end collision risk of vehicles more accurately.

- **Keywords:** Reaction time; Car-following; Rear-end crash risk; Accumulator model; Wiedemann model; Truck; Looming

Pablo Arocena, Laura M. García-Carrizosa. *Determinants of the duration of sick leave due to occupational injuries: Evidence from Spanish manufacturing. Pages 311-317.*

Introduction: Despite the significant economic impact of occupational injuries on companies and society, studies focused on analyzing the determinants of workdays lost due to sick leave remain scarce and incomplete. This paper contributes to this issue by (a) analyzing the drivers of sick leave duration, distinguishing factors that explain the health recovery time from those that could lead workers to a voluntary extension of the absence period, and (b) formulating and empirically testing the effect of gender, citizenship, temporary work, job tenure, amount of disability benefit, and size of the injured worker's firm on the number of days the employee is off work after the injury. **Method:** Hypotheses are tested on a comprehensive dataset that includes all nonfatal occupational injuries causing sick leave that occurred in the manufacturing sector in Spain during 2015–2019, with more than 400,000 injuries. We conduct ordinary least squares and count data regression models in which the number of days off work is regressed on employees and work characteristics while accounting for a set of variables

to control the injury's nature and severity. **Results:** The results show that after considering the intrinsic characteristics of the injury and the severity of the worker's injuries, women, native workers, workers with more seniority, workers with higher salaries, and those working in larger companies have longer periods of sick leave. The results suggest that moral hazard considerations significantly impact the time to return to work after an occupational injury. **Practical applications:** Based on the findings, several insights for company managers and public decision-makers are discussed. Specifically, interventions aimed at improving the organization of work and the working conditions of workers in manufacturing industries are highlighted, as well as the need to improve control and supervision mechanisms during the recovery process of injured workers.

- **Keywords:** Work-related injuries; Working days lost; Moral hazard; Absenteeism; Recovery time

Chao Xu, Lin Guo, Kai Wang, Tong Yang, Yufeng Feng, Haiyan Wang, Dan Li, Gui Fu. *Current challenges of university laboratory: Characteristics of human factors and safety management system deficiencies based on accident statistics.* Pages 318-335.

Introduction: In recent years, with the rapid development of university laboratory construction, frequent laboratory accidents have aroused widespread concern. There is an urgent need to improve laboratory safety management's effectiveness further, enhance laboratory accident prevention ability, and reduce the occurrence of accidents. **Method:** Based on the accident causation theory, this paper uses the accident analysis path of 24Model and the logical idea of WBA (Why-Because-Analysis) to statistically analyze the causative factors of 64 typical college laboratory fire and explosion accidents and find out the defects of current college laboratory management. **Results:** The study showed that unsafe human actions at the individual level were the most critical factors affecting laboratory safety management, with a high frequency of violations of experimental procedures (105 times) and managers' failure to perform their supervisory duties (98 times); low safety awareness and insufficient safety knowledge among laboratory personnel were key factors triggering unsafe actions. At the organizational level, the lack of training programs (92 times) and the lack of systematic procedures (106 times) are the weaknesses of the laboratory safety management system in general in all universities; the lack of safety culture construction is the root cause of laboratory management deficiencies. **Conclusions:** Based on the above statistical results, and taking into account the characteristics of university laboratories themselves, the root causes of poor safety are specifically analyzed and preventive measures are proposed in six areas to address the key causes of accidents. **Practical Applications:** The results of this study are essential for improving the ability to prevent accidents in flammable and explosive laboratories in universities.

- **Keywords:** University laboratory safety; Statistical analysis; Accident cause model; Safety management; Prevention countermeasures

Sreeja Thallapureddy, Fred Sherratt, Siddharth Bhandari, Matthew Hallowell, Hayley Hansen. *Exploring bias in incident investigations: An empirical examination using construction case studies.* Pages 336-345.

Introduction: Incident investigation is a foundational tool of safety management. Determining the causal factors of any incident underpins organizational learning and subsequent positive change to processes and practices. Research of incident investigation has largely focused on what information to collect, how to analyze it, and how to optimize resultant conclusions and organizational learning. However, much less attention has been paid to the process of information collection, and specifically that of subjective

information obtained through interviews. Yet, as all humans are biased and can't help being so, the information collection process is inevitably vulnerable to bias. **Method:** Simulated investigation interviews with 34 experienced investigators were conducted within the construction industry. **Results:** Common biases were revealed including confirmation bias, anchoring bias, and fundamental attribution error. Analysis was also able to unpack when and how these biases most often emerged in the interview process, and the potential consequences for organizational learning. **Conclusions:** Being biased to a certain degree will remain inevitable for any individual, and therefore, efforts to mitigate the effects of biases is necessary. **Practical Applications:** Increased awareness and insights can support the development of processes and training for investigators to mitigate its effects and thus enhance learning from incidents in the field prevent reoccurrence.

- **Keywords:** Bias; Construction Industry; Incident Investigation; Learning from Incidents

Aimee E. Cox, Jessica B. Cicchino, Ian J. Reagan, David S. Zuby. *Prevalence of distracted driving by driver characteristics in the United States.* Pages 346-356.

Introduction: Distracted driving is a long-standing traffic safety concern, though common secondary tasks continually evolve. The goal of this study was to measure the prevalence of self-reported distracted driving behaviors, including activities made possible in recent years by smartphones. **Methods:** We conducted a nationwide survey of 2,013 U.S. licensed drivers (ages 16+). We created four aggregate distraction categories from 18 individual secondary tasks to estimate the proportion of drivers study-wide and by demographic characteristics belonging to each category, defined as those who regularly did (during most or all drives in the previous 30 days) one or more secondary task within each category. Logistic regression estimated the adjusted odds of drivers belonging to each aggregate distraction category by demographic characteristics. **Results:** Sixty-five percent of drivers reported doing at least one of the 18 secondary tasks regularly, and half did at least one device-based task regularly in the past 30 days. Non-device task prevalence trended downward with age, while device-based task prevalence was consistent among younger drivers before declining beginning with age 35. Males (OR, 1.53; 95% CI, 1.16, 2.02), parents of children ages 18 and younger (OR, 1.47; 95% CI, 1.10, 1.96), and participants who drive in the gig economy (OR, 3.85; 95% CI, 2.73, 5.43) had higher adjusted odds of engaging in "modern" device-based distractions enabled by smartphones (e.g., making video calls, watching videos, using social media) than other drivers. Many drivers are using hands-free capabilities when available for tasks, but for some tasks more than others. **Conclusions:** Regular distracted driving is widespread with most behavior concentrated among drivers younger than age 50, though no age group or other demographic studied abstains. **Practical Applications:** Stakeholders can use these findings to develop countermeasures for distracted driving by targeting specific secondary tasks and the demographics most likely to report regularly doing them.

- **Keywords:** Distracted driving; Gig economy; Device distractions; Hands-free technology

Eva L. Bergsten, Linnea Kjeldgård, Helena Stigson, Kristin Farrants, Emilie Friberg. *Fall and collision related injuries among pedestrians, sickness absence and associations with accident type and occupation.* Pages 357-363.

Objectives: This study explores pedestrian fall accidents and collisions with other road users in the Swedish road transport system, and sickness absence (SA) in relation to

accident type, injury, and occupation. Further, it studies the associations between accident type, occupation, and duration of SA. **Methods:** Data from several national registers were used that included 15,359 working age pedestrians (20–64 years) receiving healthcare after a fall or collision throughout 2014–2016. Individual characteristics, accident type, injury, and occupation were presented and related to SA. Logistic regression was used to estimate odds ratios (OR), with 95% confidence intervals, for associations between accident type, occupation, and SA duration. **Results:** About 11,000 pedestrians (72%) were involved in fall accidents in the road traffic environment and well over 4,000 in collisions with another road user; 22% of all injured pedestrians had a new SA. The population had a higher proportion of women and individuals in older age groups (≥ 45). Of the falls, 31% were due to snow or ice, and these were associated with a higher OR for both short SA (< 90 days) 1.76 (95% CI 1.56–1.98) and long SA (≥ 90 days) 1.81 (95% CI 1.51–2.18), compared to the group slipping, tripping, and stumbling. The working sectors health & social care, and construction had the highest ORs for SA. A higher OR was found for health & social care, short SA 1.58 (95% CI 1.38–1.81), long SA 1.79 (95% CI 1.45–2.20) and for construction, short SA 1.56 (95% CI 1.24–1.96), long SA 1.75 (95% CI 1.26–2.44), compared to the sector finance, communication, & cultural service. **Conclusions:** The OR for having short and long SA was higher in falls due to snow or ice and differed between occupational sectors. Practical implications: This information contributes to the knowledge base for planning a safe road transport system for pedestrians.

- **Keywords:** Traffic accidents; Walking; Insurance medicine; Register data; Sick leave

Xavier Baraza, Natàlia Cugueró-Escofet, Rubén Rodríguez-Elizalde. *Statistical analysis of the severity of occupational accidents in the mining sector. Pages 364-375.*

Introduction: The aim of this paper is to understand the causes of occupational accidents in Spain's mining sector in order to propose action plans and improve future accident rates. **Method:** This research analyzed a pool of data on 15,032 accidents occurring in the mining sector and reported to authorities between 2013 and 2018. Accidents are divided into three levels of severity: light, serious, and fatal. We study the influence of 12 variables on the accident severity rate in our sample. **Results:** The results show that accident severity is related to age, gender, nationality, length of service, economic activity, company size, accident location, days of injury leave, day of the week, deviation, injury, and specific Spanish region. This sector produces a high rate of serious accidents compared to all other sectors; has a male-dominated, older and experienced workforce; and employs mainly Spanish workers. Its activity is concentrated in larger companies and the work involves the use of heavy machinery and dangerous materials. We offer conclusions and future lines of research to help regulators, companies and workers to improve worker safety.

- **Keywords:** Occupational safety; Mining; Health and safety; Accident rate; Occupational accidents

Kadir Arifin, Mohamad Xazaquan Mansor Ali, Azlan Abas, Mohd Akhir Ahmad, Mohamad Azrin Ahamad, Amirul Shazli Sahimi. *The influence of hazard control and prevention toward safety behaviors and safety outcomes in coal-fired power plants using PLS-SEM. Pages 376-389.*

Introduction: The electrical utility industry, which plays a vital role in sustaining other sectors, contributes to high occupational accident rates in the utility industries. The high accident rate shows that there has been insufficient effort made to control unsafe actions and conditions in the workplace. This study aims to examine the influence of hazard

control and prevention as leading indicators of safety behaviors and outcomes in coal-fired power plants in Malaysia. **Methods:** This quantitative research was conducted by distributing survey questionnaires randomly to five coal-fired power plants in Peninsular Malaysia. A total of 340 respondents were involved in this research. Partial least squares structural equation modeling (PLS-SEM) analysis was performed using SmartPLS to validate and examine the relationship of the proposed model. **Results:** The results validate the construct of hazard control and prevention consisting of planning, action, managing, and verifying, while the safety outcomes construct consists of occupational accidents, fatal accidents, near misses, and lost time injuries. The results indicate that hazard control and prevention significantly relate to safety compliance, safety participation, safety motivation, and safety knowledge. Moreover, safety outcomes were influenced negatively by hazard control and prevention through safety compliance. **Conclusion:** The model provides a better understanding of the influence of hazard control and prevention on safety behavior and outcomes. **Practical Applications:** The model can be used as guidance for practitioners and researchers in planning and implementing hazard control and prevention to improve health and safety in the workplace.

- **Keywords:** Hazard control; Hazard prevention; Safety management practices; Leading indicators; PLS-SEM

Hayley McDonald, Janneke Berecki-Gisolf, Karen Stephan, Stuart Newstead. *Personality, perceptions and behavior: A study of speeding amongst drivers in Victoria, Australia. Pages 390-400.*

Introduction: Road crashes present a serious public health issue. Many people are seriously or fatally injured every year in avoidable crashes. While these crashes can have multiple contributing factors, including road design and condition, vehicle design and condition, the environment and human error, the performance of illegal driving behavior, including speeding, may also play a role. The current study aimed to examine the mediating influence that four potential deterrents (perceptions towards enforcement, crash risk, social norms and disapproval, and negative personal/emotional affect) have between the Big Five personality traits (conscientiousness; extraversion; agreeableness; neuroticism; openness) and expectations to speed. **Methods:** A total of 5,108 drivers in Victoria, Australia completed an online survey in 2019. A mediated regression analysis was used to examine pathways in a conceptual model developed for the study. **Results:** The results showed that perceptions towards the four potential deterrents examined did mediate the relationship (either completely or partially) between personality and expectations to speed. **Conclusions:** The results of this study suggest that if interventions to deter illegal driving behavior are to be successful, one factor that could be taken into account is the personality traits of drivers who may be at greatest risk of the performance of illegal driving behaviors.

- **Keywords:** Driver behavior; Deterrence; Personality; Speeding; Illegal driving

Neil Ortmann, Yara K. Haddad, Laurie Beck. *Special Report from the CDC: Provider knowledge and practices around driving safety and fall prevention screening and recommendations for their older adult patients, DocStyles 2019. Pages 401-408.*

Introduction: Falls and motor-vehicle crashes (MVCs) are leading causes of unintentional injury deaths among older adults (65+) in the United States. Injury prevention resources exist to help healthcare providers reduce fall and MVC risk among older adult patients. However, awareness of these resources among healthcare providers is unclear. **Methods:** Questions were included in the 2019 DocStyles survey that assessed healthcare provider awareness of three injury prevention resources: (1) the

American Geriatrics Society's (AGS's) Clinician's Guide to Assessing and Counseling Older Drivers, (2) the Clinical Assessment of Driving Related Skills (CADReS), and (3) the Centers for Disease Control and Prevention's (CDC) Stopping Elderly Accidents, Deaths, and Injuries (STEADI) initiative. We also explored the circumstances and current practices for counseling older adult patients on fall prevention and driving safety. **Results:** Only 20% of providers reported awareness of any of the injury prevention resources. Providers were more likely to report either screening for fall risk or unsafe driving when an older adult presented with a fall concern (74.5%) or driving concern or recent crash (85.1%), compared to annual screening for fall risk (67.7%) or driving safety (47.7%). More providers reported discussing the increased fall or MVC risk associated with patient medications, referring patient for driving fitness evaluations, or discussing alternative transportation options with the patient after adverse events or patient-initiated concerns compared to routine annual discussions. **Conclusion:** Healthcare gaps persist in the screening and assessment of older adult risk factors for falls and unsafe driving. Limited provider awareness of clinical resources related to preventing older adult falls and unsafe driving may be contributing to these healthcare gaps. **Practical Applications:** Improving healthcare provider awareness of these resources could help them identify older adults at risk of a fall or MVC and promote injury prevention efforts in their clinical practices.

- **Keywords:** Injury Prevention; Fall; Motor Vehicle Crash; Health Behavior; Clinician Guidelines