Slips and Falls in Restaurants
Reducing Worker Risk

Liberty Mutual Research Institute for Safety
Scientific Update

from Research to Reality
Dear Readers

With the summer travel season upon us, the restaurant industry is in full swing. During peak seasons, restaurant operators must often step up their safety efforts to meet the needs of an increased number of employees and a faster pace of operations. Controlling hazards that can lead to same-level slips and falls—a leading cause of injury among restaurant workers—should top their safety lists. This issue highlights the findings from our recent study of worker slips and falls in limited-service restaurants (see pp. 4-7). Our findings provide the scientific basis for targeted safety interventions that can effectively reduce slip and fall hazards in restaurants and other at-risk industries.

However, generating scientific knowledge is only half the battle in combating workplace hazards. This knowledge must be translated into practical tools and recommendations that industries can use to enhance workplace safety. In an interview with Wayne Maynard, Manager of Technical Services and Product Development for Liberty Mutual’s Loss Control Advisory Services, we take a glimpse at this research-to-reality translation process as it applies to the restaurant study findings (see p. 8).

I hope you enjoy this issue, and, as always, we invite your feedback.

Ian Noy, Ph.D.
Vice President and Director

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For at least the past decade, same-level falls have consistently ranked second among the top 10 causes of serious workplace injuries in the United States (Liberty Mutual Workplace Safety Index, 2000-2010). High-risk industries include healthcare, hospitality, and construction, but the restaurant industry—which employs more than 6.5 percent of the nation’s workforce—is among those most burdened by injuries from same-level slips and falls.

“In 2009, the restaurant industry reported more than 50,000 cases of disabling work-related injuries. Nearly a quarter of those were attributed to same-level slips, trips, and falls,” notes the Institute’s Center for Injury Epidemiology (CIE) Director, Theodore Courtney, M.S., CSP, citing the most recent statistics on the subject (BLS Table R4, 2009). “The fast pace of restaurant operations, coupled with the reality of spills and floor contamination, can create an environment where fall risks are common— but that doesn’t mean slips and falls are inevitable or uncontrollable,” asserts Courtney. “By giving us a better understanding of the mechanisms and circumstances that lead to same-level slips and falls, our research provides an evidence base for interventions that can effectively reduce the risk of related injuries.”

The Liberty Mutual Research Institute for Safety has a distinguished history of research targeting same-level falls. In 1967, the Research Institute developed and tested the first Horizontal-Pull Slipmeter™, which enabled safety practitioners to obtain objective measures of floor slipperiness and thereby gauge the risk of slips and falls. Throughout the ’70s, ’80s, and ’90s, Institute laboratory studies yielded valuable information about the interactions between floor and shoe surfaces as well as the impact of friction and surface roughness on slipping. More recently, the Research Institute has taken a multidisciplinary approach to the problem, applying tribology, biomechanics, epidemiology, and the behavioral sciences to improve researchers' understanding of the causes and control of same-level slips and falls.

In 2000, the Institute convened a Hopkinton Conference of prominent scientific experts from around the world to explore issues related to same-level falls and to identify new research opportunities. The conference proceedings, published as a special issue of the journal Ergonomics (Vol. 44, No. 13, 2001), identified a number of important research gaps, including a lack of field studies applying the best available research methods. “While considerable laboratory science on slipping and falling had been done, there was a clear need to move the research into actual workplaces,” explains Courtney.

The Institute responded to this need with a series of field research initiatives, including a large-scale study of restaurant workers conducted with the Harvard School of Public Health. Launched in 2007, this ongoing study is the largest study to date that examines and quantifies the factors that contribute to slip risk among limited-service restaurant workers. “Through this multifaceted research study,” notes Courtney, “we are gaining a more comprehensive understanding of the circumstances that lead to same-level restaurant falls and the impact of various risk factors. This knowledge will enable employers to make more informed decisions regarding worker safety, not only in restaurants but potentially in other high-risk fields, such as hospitality and healthcare.”
Because same-level falls are responsible for one of four disabling restaurant worker injuries in the United States, understanding the factors that contribute to such events is critical. Scientists at the Liberty Mutual Research Institute for Safety dedicate significant time and resources to studying the mechanisms and circumstances that lead to same-level falls. In addition to controlled laboratory investigations, Institute researchers conduct field studies in actual work environments, collecting data from restaurant workers during operating hours. These real-world studies provide the evidence base for safety protocols and best-practice recommendations that can help restaurants reduce the risk of same-level falls.

Initially, Research Institute scientists conducted a study involving 10 limited-service (a.k.a. fast-food) restaurants. Applying a unique approach, researchers collected workers’ self-reports of slips and falls experienced during the four weeks prior to the study. The findings, published in *Injury Prevention* (Vol. 16, No. 1, 2010), revealed a high frequency of slipping among restaurant workers and quantified a significant association between a restaurant’s mean coefficient of friction (COF) and workers’ odds of slipping.

“Many laboratory studies have shown friction to be associated with slipping, but such studies are not necessarily representative of real-world conditions. We wanted to evaluate risk factors within active work environments,” explains Theodore Courtney, M.S., director of the Institute’s Center for Injury Epidemiology (CIE). “This study demonstrated that we could use self-reported slipping as a dependent variable to study the causes of same-level falls. Knowing this, we were able to design a more in-depth study in which we examined the impact of multiple risk factors for same-level slips and falls over a longer period of time.”

The Institute’s next step was to launch a large-scale prospective field study of various risk factors for slipping. The study, conducted in collaboration with scientists at the Harvard School of Public Health, sought to assess whether, and to what extent, factors such as floor surface characteristics, slip-resistant shoes, floor cleaning practices, and safety climate impact a worker’s risk of slipping.

“We recruited 36 fast-food restaurants across six states and gathered individual and environmental data at each site over a two-year period,” relates the study’s principal investigator, Santosh Verma, Sc.D., research scientist at the CIE. At baseline, participating restaurant workers completed a survey on demographics (age, gender, education, ethnicity, height, weight), job characteristics (tenure, primary location of work, number of hours per week, work hours), perceptions of floor
slipperiness, floor-cleaning practices, and slip-resistant shoe use. The study team also measured floor surface roughness (average and peak) and COF in selected areas (front counter, drive-through, sandwich assembly, fry vat, grill, back vat, sink, cooler, freezer, and ice machine).

During the subsequent 12 weeks, participants were asked to report their slip experiences each week through an online, telephone, or paper survey. A “slip” was defined as a loss of traction of the foot. “We made sure that study participants understood that we were interested in finding out about all slips, even those that didn’t result in a fall,” notes Verma. “That is important because slips occur at a higher frequency than falls, and many slips can result in injury without necessarily causing a fall.” Restaurant managers provided additional information on floor-cleaning protocols and shoe policies.

Initial Findings Suggest That Slips Are Controllable

Initial analyses, as published in the *Journal of Occupational and Environmental Hygiene* (Vol. 7, No. 9, 2010), indicated that the overall rate of slipping was 0.44 slips per 40 work hours during the 12 weeks of the prospective study. The individual rate of slipping was more than 100 times higher in the restaurant with the highest rate of slipping compared to the restaurant with the lowest rate of slipping (range 0.02 to 2.49 slips per 40 work hours).

“It is highly unlikely that this large between-restaurant variation could be attributed to chance alone,” notes Verma. “This finding suggests that some restaurants are much more effective at controlling the risks than others, and it implies that adoption of best practices has considerable potential to reduce the risk of slipping.”

The study data also revealed that 25 out of the 36 restaurants used enzyme-based floor cleaners. Unfortunately, 62% of the participants who were responsible for using these cleaners reported using hot or warm water as part of their floor-cleaning protocol. “That’s a problem because—unlike traditional floor cleaning products—enzyme-based cleaners require cold water to work properly. Using hot or warm water can reduce the effectiveness of the cleaner by deactivating the enzymes,” explains Verma. “This finding indicates that training and enforcement of proper cleaning protocols are important aspects of reducing slip risk in restaurants.”

Slip-Resistant Shoes Cut Slip Rates in Half

In subsequent analyses, researchers examined the associations between floor surface characteristics, slip-resistant shoes, floor cleaning frequency, and slip risk. As published in *Occupational and Environmental Medicine* (Vol. 68, No. 4, 2011), slip-resistant shoes reduced the rate of slipping by more than 50%. “Ours is the first study to provide concrete evidence that slip-resistant shoes are effective in the field. This is a very exciting finding because slip-resistant shoes are a straightforward intervention,” states Verma, who notes that about 60% of study participants reported wearing slip-resistant shoes at the time of the investigation. “Based on our findings, Ours is the first study to provide concrete evidence that slip-resistant shoes are effective in the field. This is a very exciting finding because slip-resistant shoes are a straightforward intervention…”

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## Case-Crossover Study Links Transient Risk Factors to Slip Rates

As part of the field study of fast-food restaurant workers (see pp. 4-7), Institute researchers conducted a nested case-crossover study to explore how three transient risk factors—rushing, distraction, and walking on a contaminated floor—affect the rate of slipping among these workers. The study also examined whether individual variables such as use or non-use of slip-resistant shoes, weekly work hours, and job tenure altered the degree of risk. The findings were accepted for publication in *Occupational and Environmental Medicine*.

### What we looked at:

Researchers analyzed baseline data provided by 396 workers, 210 of whom reported experiencing one or more slips, for a total of 989 slipping incidents.

The data included:
- average work hours,
- job tenure,
- weekly slip experience, and
- average weekly exposure duration to each transient risk factor.

Researchers were specifically interested in whether one or more transient risk factors were present at the time of slipping.

### What we found out:

- **All three transient risk factors significantly increased the rate of slipping:**
  - rushing by 2.9 times
  - distraction by 1.7 times
  - walking on a contaminated floor by 14.6 times

- **Slip-resistant shoes helped reduce the risks of both rushing and walking on a contaminated floor.**

- **The effects of all three transient risk factors decreased monotonically as job tenure increased.**

### Conclusions:

Based on these findings, our researchers concluded that the following could help reduce slipping incidents in fast-food restaurants:
- reducing the transient exposures,
- encouraging the use of slip-resistant shoes, and
- establishing a greater safety focus for new and part-time employees.

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and earlier studies indicating the high costs associated with fall-related injuries, restaurants that provide slip-resistant shoes should see a return on their investment."

Researchers also found that the mean COF among the studied restaurants ranged from 0.45 to 0.86. Further, they found that for each 0.1 increase in the mean COF, the rate of slipping decreased by 21%. This finding is significant, because current guidelines cite 0.5 as a recommended COF. “Our study shows that there are significant reductions in risk for each 0.1 COF increase at values well above 0.5, suggesting that efforts to further improve friction can have an impact,” explains Verma.
Floor Cleaning – Is More Better?

According to the study findings, the rate of slipping was 15 times higher on contaminated floor surfaces, and workers were exposed to contaminated floors for 1/3 of their work time. After controlling for other factors, however, the association between floor-cleaning frequency and rate of slipping was not as clear-cut. Verma explains, “The cleaning process itself puts liquid ‘contaminants’ on the floor, which may increase slip risk in the short term. But your floor should be more slip-resistant once the contaminants are removed and the water has evaporated. So the question of how often the floor should be cleaned to minimize slips requires more study.”

Researchers continue to analyze the study data to explore the effects of safety climate and working hours on slips and falls, to identify who is wearing slip-resistant shoes, and to examine the relationship between perceptions of slipperiness and measured COF. “We still have a great deal to learn from this study,” concludes Verma, “but we are confident that our findings will result in the development of better prevention tools, training, and work processes to help reduce occupational slips and falls in restaurants.”

New Directions

On the heels of the limited-service restaurant study, Institute researchers have begun data collection for a prospective cohort study of risk factors for slips, trips, and falls among full-service restaurant workers. In addition to assessing floor surfaces, slip-resistant shoes, floor cleaning, and safety climate, this study will examine the effects of lighting, floor level and transition, as well as risk factors for tripping and slipping. “This new study expands the scope of research to a different type of restaurant environment and will examine additional factors related to slips, trips, and falls among restaurant workers,” concludes Verma, whose goal is to recruit 50 full-service restaurants for the study.

“...we are confident that our findings will result in the development of better prevention tools, training, and work processes to help reduce occupational slips and falls in restaurants.”

Related Papers


As Manager of Technical Services and Product Development for Liberty Mutual’s Loss Control Advisory Services, Wayne Maynard, CSP, CPE, ALCM, oversees the development of consulting tools, resources, and training used by Liberty Mutual loss control consultants to help companies reduce risk. He works closely with Research Institute scientists to integrate findings from published studies into effective loss control solutions, products, and tools. We asked Mr. Maynard to comment on the Institute’s field investigation of slips and falls among restaurant workers and how its findings impact safety practice.

Q In your experience, what is the most significant aspect of slips-and-falls management in restaurants?

A The most valuable aspect of an effective slips-and-falls safety management program is sound policy, properly implemented, with accountability from all major stakeholders. This is a considerable challenge because safety policies tend to get lost in the restaurant business, which is fast-paced and which focuses, appropriately, on customer service. However, once managers recognize the potential to make an impact on the bottom line, they begin to understand the value of sound safety policy, reinforced by proper training and accountability.

Q How does the restaurant study address that aspect?

A The findings of the restaurant study provide quantifiable evidence that certain practices—proper floor maintenance and cleaning, along with slip-resistant shoe use—can effectively reduce the risk of slipping. This evidence is used to inform and support safety policies and practices that can make a real difference in the field. Company stakeholders are more apt to take safety recommendations seriously when there is supporting evidence of their effectiveness.

Q Which findings were the most surprising or intriguing to you?

A Without a doubt, the most intriguing finding was that incremental increases in a floor’s coefficient of friction, or COF, can make a real difference in lowering slipping rates. We learned that for every 0.1 increase in a kitchen floor’s mean COF, there was a corresponding 21 percent decrease in slips reported by workers. That’s much greater than what might have been expected. This finding tells us that any efforts to improve floor COF—keeping the floor clean and dry, applying floor surface treatments, or selecting slip-resistant floorings—can enhance worker safety and produce savings by reducing the rate of slipping.
**Q** Which findings from the restaurant study impact safety practices the most? Explain.

**A** The study showed that wearing slip-resistant shoes can reduce employees’ risk of slipping by half. With this knowledge, restaurant operators can create sound policies to facilitate slip-resistant shoe use, and they may be more likely to provide or help finance slip-resistant shoes for their employees, knowing that doing so could provide a return on their overall investment.

The study also showed a 15-fold increase in the rate of slipping when employees were working on contaminated floor surfaces—which occurred during one-third of their work time. It also indicated that enzyme-based floor cleaners are used incorrectly more often than not and that this misuse compromises their effectiveness. These findings make a strong case for the development of effective floor-cleaning policies that include procedures for removing debris such as food, spilled drinks, and other objects from the floor.

**Q** What is the central message of the study?

**A** Essentially, the study shows that a strategy aimed at maintaining the best possible COF in restaurant kitchens can reduce the risk of injuries from slips and falls, and that slip-resistant shoes and proper floor cleaning are two very important and effective components of such a strategy.

It is important to note, however, that neither slip-resistant shoes nor proper cleaning protocols offer a “silver-bullet” solution to the problem of slips and falls. These solutions must be incorporated into a comprehensive slips-and-falls management process that incorporates many other components, including management responsibility, education and training, floor surface selection and treatments, hazard surveillance and assessment, and warning signs and instructions.

**Q** How is Loss Control Advisory Services (LCAS) using the study’s findings to help improve worker safety in restaurants?

**A** When research is completed in a specific area, LCAS product directors take action to incorporate the findings into practical resources that help companies better control risks. In the case of the restaurant study, this integration has occurred on several levels. For example, we have integrated the study findings on slip-resistant shoe use and floor cleaning protocols into our Slips and Falls Prevention Toolkit. This toolkit includes assessment tools, solution guides, and training programs designed to help companies take a more proactive approach to controlling workplace slips and falls. We are also incorporating the findings into our education and training programs for LCAS field consultants and service directors.

Our most recent program, VantageControl for Restaurants™, will incorporate findings from this study, and other studies related to slips and falls prevention in restaurants. Delivered through a variety of channels, including Liberty Mutual’s SafetyNet.com, the VantageControl program provides policyholders with telephonic and onsite consults from LCAS specialists, as well as focused training through interactive webinars and online discussion boards.

**Q** In your opinion, do any of the study findings have implications for other industries or for general liability concerns?

**A** Although the study findings are directly transferrable to the restaurant industry only, I believe that they also have potential implications for other industries—particularly the finding that incremental increases in COF are associated with decreased rates of slipping. The study provides a scientific basis for saying that even small improvements to a floor’s COF can reduce the rate of slips and falls. This has important implications not just in restaurants, but also in the healthcare, hospitality, retail, and grocery industries, as well as other industries challenged by slips and falls, not only in relation to workers compensation, but also from a general liability standpoint.
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Telephone: 1-508-497-0205
E-mail: researchinstitute@libertymutual.com