from Research to Reality

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Liberty Mutual Research Institute for Safety

Pace Yourself
What You Should Know About Slips, Trips, & Falls

Same-Level Slips & Falls
Multifaceted Research Helps Expose Root Causes

Making Strides in Slips & Falls Prevention

Vol. 10 No. 3

PACE YOURSELF

What You Should Know About Slips, Trips, and Falls

Did you know the average construction worker may take 9,646 steps per day while on the job? According to a 2004 study commissioned by the American Council on Exercise, workers with relatively low active jobs (such as office workers) average 4,327 steps at work, and workers with highly active positions (such as mail carriers) average 18,904 steps. That's a lot of steps and that's just steps while on the job. With so many steps per day, the exposure to slip, trip, and fall hazards can be very high. Fortunately, walking is a highly developed skill, and in the vast majority of cases, people are able to cope with the hazards they encounter on a daily basis and can safely avoid incident. However, most people do slip, trip, or fall from time to time for a variety of reasons.

In fact, slips, trips, and falls are a serious public health concern. They can result in a variety of injuries, including fractures, sprains, strains, cuts, abrasions, and even death. According to the U.S. National Center for Health Statistics, from 2003 to 2004 falls accounted for 34 percent of hospital emergency department injury visits for men 65 years of age and older. For women in that age group, more than 48 percent sought treatment. And, as for fatalities, the National Safety Council reports more than 17,000 U.S. deaths due to falls in 2003.

In the workplace, slips, trips, and falls are also a major concern. According to the 2006 Liberty Mutual Workplace Safety Index, the annual direct cost of disabling occupational injuries due to slip, trips, and falls is estimated to exceed $11 billion. The Index reports that falls on same level are the second most costly occupational injury (estimated annual cost of $6.7 billion), just behind overexertion. The Index also shows that bodily reaction, which comprises injuries from slipping or tripping without falling, is the third highest injury category, followed by falls to lower level (4.6 billion).

The statistics say it all – slips, trips, and falls are a leading cause of injury. These injuries may result in employee absence, lost productivity, high workers compensation claims, and reduced employee morale. In 2005, falls in the work-

place accounted for more than 700 deaths and more than 200,000 injuries involving days away from work, according to the Bureau of Labor Statistics.

To help reduce the incidence of occupational slips, trips, and falls, the Liberty Mutual Research Institute for Safety conducts cutting-edge research. Institute scientists publish findings in peer-reviewed journals, organize and participate in a variety of international forums, and help to develop interventions and guidelines to reduce the incidence of occupational injuries. In its formative years, the Institute was a pioneer in the field, developing tools, such as the horizontal-pull slipmeter, to measure floor slipperiness. Today, the Institute applies a multifaceted research approach using the disciplines of tribology, biomechanics, psychology, and epidemiology to better understand the conditions and mechanisms that can lead to slips, trips, and falls.

What do we know about slips, trips, and falls? Let's take a few steps back and examine the basics.

Slips: The act of slipping occurs when a person's heel slides suddenly or involuntarily on a walking surface and causes a loss of balance. It occurs just as the heel contacts the floor and the weight shifts to the heel. Typically, slips occur when there is too little friction or traction between a person's foot or shoe and the walking surface. A slip most often results in the person falling backward. Slips can occur due to faulty housekeeping, contaminants (such as oils, water, etc.), weather hazards, inappropriate or worn flooring, and improper or worn footwear.

Trips: Trips occur when the body's center of gravity is in motion, and the toe collides with a near ground obstacle, which causes the foot movement to abruptly stop. When this occurs, the center of gravity rapidly moves out of the area of the body's base of support (the planted foot) and often results in a fall. In this case, the person usually falls forward.

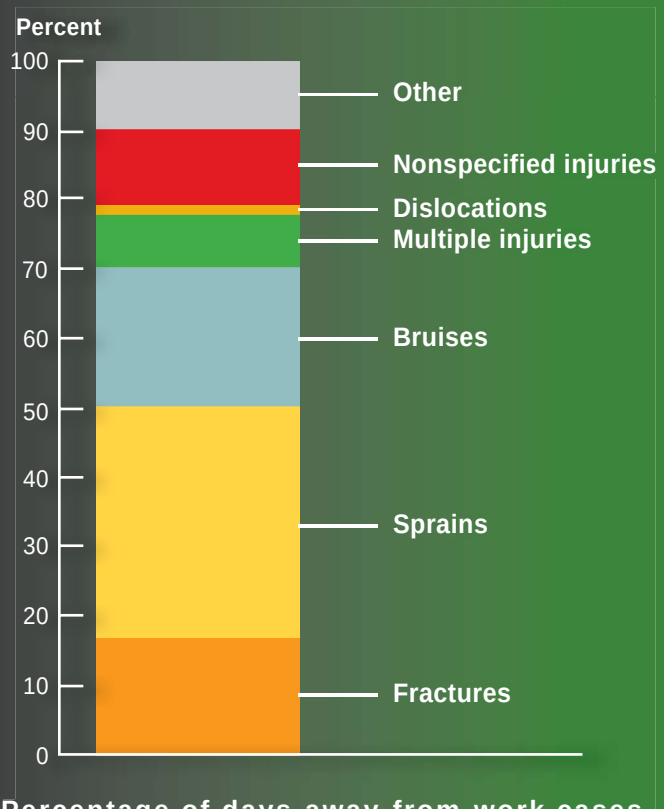
A person may also lose balance and fall as a result of a misstep or air step. For example, when descending down a stairway or stepping off of a curb, he or she may "step off into thin air." Typically, the person falls forward in this situation. In addition, missteps may occur when a person steps forward and down and the foot lands on a higher object. In this case, he or she tends to fall forward or sideways. Common causes of tripping and missteps include obstructed walkways, uneven surfaces, and poor lighting.

Falls to Lower Level: More than 60 percent of falls to a lower level involve falls of less than 10 feet. While falls to a lower level occur less frequently than same-level falls, they usually have a higher degree of severity. Such falls may result in fractures and death. This type of fall includes falls from ladders, falls from vehicles and equipment, falls from loading docks, and falls on stairways.

Same-Level Falls: Same-level falls may result from a slip and fall, trip and fall, or misstep and fall. These types of falls are more frequent than falls from elevation; however, they are typically less severe. Injuries resulting from same-level falls may include lower back strain, hand/wrist sprain, or ankle sprain.

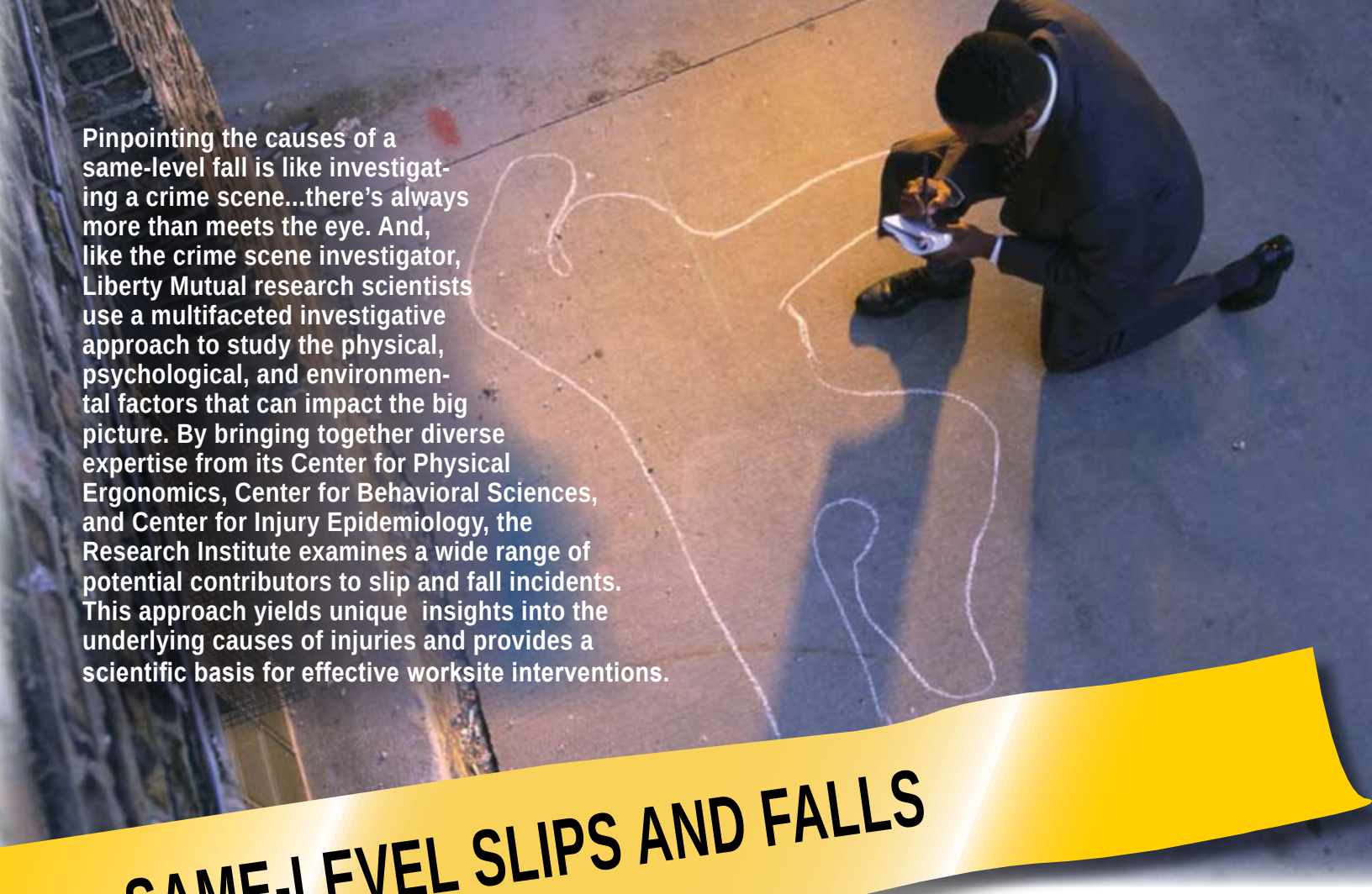
There is much more to explore beyond the basics when it comes to slips, trips, and falls. The pages ahead will tread through some of these additional concepts while focusing on the area of same level slips, trips, and falls – one of the largest areas of occupational injury. Read on to learn more about the many related scientific investigations at the Research Institute and find out how to reduce the likelihood of same-level slips, trips, and falls in the workplace.

TYPES OF INJURIES resulting from SAME-LEVEL FALLS



Percentage of days-away-from-work cases involving falls on the same level by injury

Source: Bureau of Labor Statistics



Pinpointing the causes of a same-level fall is like investigating a crime scene...there's always more than meets the eye. And, like the crime scene investigator, Liberty Mutual research scientists use a multifaceted investigative approach to study the physical, psychological, and environmental factors that can impact the big picture. By bringing together diverse expertise from its Center for Physical Ergonomics, Center for Behavioral Sciences, and Center for Injury Epidemiology, the Research Institute examines a wide range of potential contributors to slip and fall incidents. This approach yields unique insights into the underlying causes of injuries and provides a scientific basis for effective worksite interventions.

SAME-LEVEL SLIPS AND FALLS

Multifaceted Research Helps Expose Root Causes

Recently, Liberty Mutual researchers completed a field investigation that illustrates the Institute's multifaceted approach to slips and falls research. The study applied tribology, psychology, and epidemiology to examine, among other things, the relationship between worker perceptions of slipperiness and actual friction measures. "Isolated friction measurements have historically been used to gauge floor surface safety; however, we know these measurements do not tell the whole story," states Wen-Ruey Chang, Ph.D., the study's principal investigator. "Other factors such as friction variations and individual perceptions of slipperiness have important safety implications," he adds. According to Chang, friction variations, which are the changes in friction that can be present on a given surface, are a critical factor. "When people unknowingly encounter a change in friction due to contamination or wear, they may not always have time to adjust their gait and avoid a fall," notes Chang, adding, "The scientific literature has long speculated on the importance of friction variations, but we wanted to collect data that could support these claims."

Worker perception of floor surface slipperiness is another critical area of study in slips and falls research. "It is important to understand individual perceptions of floor surface slipperiness because perceptions often influence behaviors," explains behavioral psychologist Yueng-Hsiang (Emily) Huang, Ph.D. "When individuals perceive a floor surface to be slippery, they typically alter their gait to avoid a slip or fall. If, on the other hand, the individual does not perceive the floor to be slippery, or underestimates its slipperiness, he or she is more likely to be caught off guard and fall. In this way, misperceptions can contribute to injuries."

Researchers recruited 10 U.S. quick-serve restaurants to participate in the study. They targeted the restaurant industry because of its historically high numbers of same-level slips and falls. In earlier epidemiological studies, Institute researchers found that one out of every three disabling restaurant worker injuries is caused by a slip, trip, or fall, with 26 percent of these being same-level falls. “Based on these and similar findings from the scientific literature, we knew that restaurants would be a good setting for examining work-related, same-level slips and falls,” explains Theodore Courtney, M.S., C.S.P., Institute director of research operations.

During an eight-week data collection phase, Institute researchers used standardized slipmeters to collect friction measurements from six critical working areas in each restaurant. These areas included the fryer, back vat, grill, sink, front counter, and walk-through. Liberty Mutual tribology experts took measurements immediately after the lunchtime rush – a time when floor contamination can be particularly high. At the same time, Institute psychologists and epidemiologists administered surveys to gather subjective data from employees who worked during the lunch period. The survey asked workers to rate the slipperiness of the six identified major working areas from “extremely slippery” to “not slippery at all.” The survey also collected individual employee and employment information and asked questions relative to recent slip history, including whether or not the employee had experienced a slip, with or without a subsequent fall, while working at the restaurant in the previous four weeks.

> “...to reduce the incidence of same-level slips and falls, we need to understand more fully the interplay among cognitive, behavioral, tribological, and biomechanical aspects of the problem...”
>
> Y. Ian Noy

As part of the initial data analyses, the Institute’s tribology researchers compared the friction measurements taken in all 10 restaurants. Among the early findings, reported in the 2005 edition of *Contemporary Ergonomics*, researchers found that the most slippery of the six kitchen areas studied was the sink area, followed by the fry vat, the walk-through, the grill, and the back vat. The front counter was the least slippery of the areas. Researchers also used the friction measurements to calculate friction variations in the key areas studied. An in-depth analysis of the measured friction variations indicated that workers had a greater than 50 percent chance of experiencing a friction reduction when stepping from one foot to the other in the studied areas. “Our findings illustrate how frequently employees encounter friction reductions in real life,” notes Chang. “Most field safety measurement practices do not include friction variations, so this was an opportunity to consider the role of such variations in slipperiness measurement.”

In the next phase of data analysis, researchers used statistical methods to calculate the correlation between actual friction measurements and subjective slipperiness ratings across all the working areas studied. The results of these statistical analyses, published in *Safety Science* (Vol. 44, 2006), describe a modest correlation between the average measured friction and the average perception rating score for each working area across all the restaurants. “This modest correlation shows that, for certain kitchen areas, workers could estimate actual floor slipperiness with some accuracy,” explains Huang. “This means that in some cases, perceptions may be a useful complement to friction measurements. But equally important, the findings suggest that individual perceptions of floor slipperiness may be impacted by factors *other* than friction. For example, human factors, such as visual cues, sensory feedback, motor control, and environmental factors, such as lighting, shoe sole condition, and contaminants, may also impact perception. It is important to examine the many different factors influencing perceptions in order to understand how to best focus prevention efforts.”

To begin to identify some of the factors other than friction that can impact perceptions, Liberty Mutual epidemiologists and psychologists examined the remaining subjective survey data from the restaurant study. These data included information on age, gender, ethnic group, tenure, work hours per week, shift length, slip history, and shoe type. Among the initial findings from this analysis, researchers noted that workers over the age of 45 did not perceive slippery conditions as well as their younger counterparts and that slip history had a significant impact on worker perceptions. The full findings of this analysis appear in the November 2006 issue of the *Journal of Occupational and Environmental Hygiene*.

Currently, Liberty Mutual researchers are conducting a biomechanical study to examine how individual visual perceptions of slipperiness and other sensory feedback received while walking can influence gait. This laboratory study investigates how individuals adapt their gait as they step from a common industrial quarry tile surface to one of five floor surfaces which were selected based on their varied visual cues (see p. 7).

“It is clear that if we want to reduce the incidence of same-level slips and falls, we need to understand more fully the interplay among cognitive, behavioral, tribological, and biomechanical aspects of the problem,” states Research Institute Director Y. Ian Noy, Ph.D. “Our multidisciplinary approach gives us unique insights into the underlying causes of same-level slips and falls so that we can better understand the best ways to avoid injury.”

Tribology

$$\mu = \frac{F}{Fn}$$

Studying the Unseen Evidence

Friction – defined by the American Heritage Stedman's Dictionary as a force that resists the relative motion, or tendency to such motion, of two bodies in contact – is one of the most significant factors impacting slips and falls. Like examining DNA evidence from a crime scene, measuring surface walkway friction requires specialized equipment and the application of science. In this case, the measurement equipment includes portable slipmeters, and the science behind the measurement is tribology.

What is Tribology? Tribology is the study of the interactions between sliding surfaces with respect to friction, wear, and lubrication. Historically, tribology has been applied in the areas of mechanical design, manufacturing processes, and machine operation to develop ways to reduce friction and increase efficiency. It has also been actively applied in slips and falls research to study the interface between the floor and shoe sole. Liberty Mutual tribology researchers study how friction, wear, and contaminants impact the potential for slips and falls.

With the aid of commercially available portable slipmeters, including the Liberty Mutual-developed horizontal pull slipmeter, Liberty Mutual tribology researchers evaluate floor surface slipperiness in real-world and laboratory settings. These devices help to determine the slip resistance of surfaces under various conditions by measuring the coefficient of friction between a test pad (representing a shoe sole) and the floor surface. A higher coefficient of friction signifies a more slip-resistant surface. For example, 0.1 is very slippery, while 0.8 is relatively non-slippery. And, while slipmeters are an important tool for studying surface slipperiness, they do have some limitations. For this reason, Liberty Mutual scientists continuously investigate the pros and cons of various slipmeters with respect to human factors, ease of use, and overall accuracy. Their findings are applied to maximize the accuracy of surface slipperiness measurement practices.

In the laboratory, Liberty Mutual scientists also study the effect of floor surface roughness and friction using portable surface roughness meters and a high-tech laboratory profilometer. These highly sensitive devices enable scientists to study the microscopic peaks and valleys of floor surfaces. By analyzing surfaces at the micrometer level, researchers can assess which surface features offer better protection against slips and falls under various conditions of contamination.

"Our in-depth investigations of floor surface features contribute to a growing body of knowledge used to inform and improve safety practices, including floor surface assessment and shoe and floor selection," states Institute scientist Wen-Ruey Chang, Ph.D.

The coefficient of friction (μ) is calculated as the ratio between friction force or horizontal (F) to normal force or vertical force (FN), or mathematically expressed as: $\mu = \frac{F}{Fn}$

Related Papers

"Preferred Surface Microscopic Features on Floors as Potential Interventions for Slip and Fall Accidents," Chang, W.R., *Journal of Safety Research*, Vol. 35, No. 1, pp. 71-79, 2004

"Field Evaluation of Two Commonly Used Slipmeters," Chang, W.R., Cotnam, J.P., and Matz, S., *Applied Ergonomics*, Vol. 34, pp. 51-60, 2003

"The Effect of Surface Waviness on Friction Between Neolite and Quarry Tiles," Chang, W.R., Grönqvist, R., Hirvonen, M., and Matz, S., *Ergonomics*, Vol. 47, No. 8, pp. 890-906, 2004

"The Effects of Cut-Off Length on Surface Roughness Parameters and Their Correlation with Transition Friction," Chang, W.R., Hirvonen, M., and Grönqvist, R., *Safety Science*, Vol. 42, No. 8, pp. 755-769, 2004

"Factors Influencing the Slip Index Measurements with the Horizontal-Pull Slipmeter," Chang, W.R. and Maynard, W.S., *Work: A Journal of Prevention, Assessment and Rehabilitation*, Vol. 26, No. 2, pp. 99-105, 2006

Award-Winning Study Provides "Clues" to Slip, Trip, and Fall Injuries

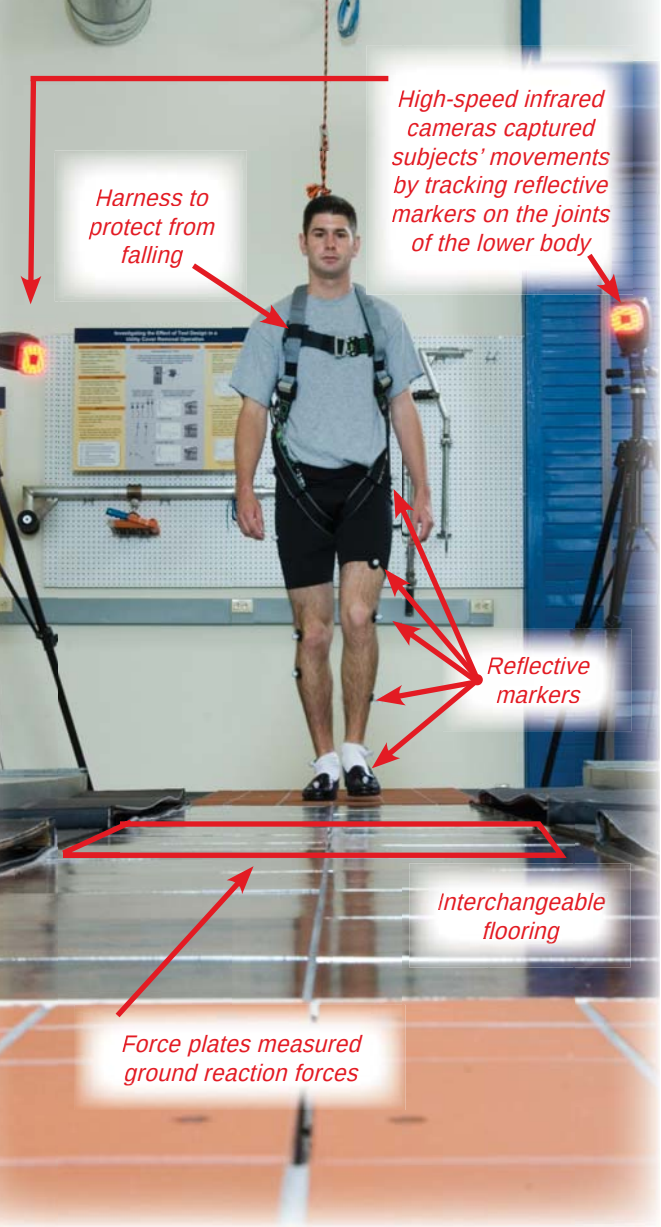
As part of an award-winning, collaborative research effort, involving the U.S. National Institute for Occupational Safety and Health (NIOSH), the Finnish Institute of Occupational Health, and other academic and industry partners, Liberty Mutual epidemiologists conducted in-depth interviews with health-care workers who had experienced a slip, trip, or fall while at work. Preliminary findings are revealing important clues about slip, trip, and fall risk factors.

Of the first 123 health-care workers interviewed, including nurses, secretaries or clerks, and health technologists and technicians, 108 reported actually falling. Of these 108, 53 percent fell after slipping and 32 percent after tripping. Sixty-four percent of the slips, trips, or falls occurred at a transitional area – wet to dry (32 percent), one type of floor to another (22 percent), or uneven surfaces (15 percent). Overall, 94 percent of subjects were injured, with an average of two injuries per event. Typical injuries included strains and sprains (29 percent), contusions (27 percent), and nonspecific pain and soreness (22 percent).

The results of this study and related collaborative studies contributed to the design and implementation of NIOSH's multifaceted, best practices, slips, trips, and falls intervention study. The intervention study focused on controlling contaminants and improving surface transitions and conditions to help reduce injuries. Initial findings indicate a substantial reduction of slips, trips, and falls among the organizations that applied the interventions.

"This research goes beyond helping prevent slip, trip, and fall incidents in health-care environments. We anticipate that the information from our study and the related NIOSH studies will be translated and applied to help prevent same-level falls in health care, with potential implications for other industries," says Institute Director Y. Ian Noy, Ph.D.

In 2006, Liberty Mutual research scientists and colleagues received the National Occupational Research Agenda (NORA) Partnering Award for Worker Health and Safety from the Centers for Disease Control. The multi-organizational award recognized the Liberty Mutual Research Institute as part of a larger collaborative research consortium, including BJC HealthCare, Washington University, the U.S. Veteran's Health Administration, the American Federation of Government Employees, Johns Hopkins University, the Finnish Institute of Occupational Health, and NIOSH. The recognition honors exemplary teamwork, innovative thinking, and strong science in the interest of worker health and safety. For more details on the award-winning research and its contributors, visit: www.cdc.gov/niosh/nora/symp06/pdfs/2006PartneringAward_STF.pdf.



Beneath the Surface

Using Biomechanics to Study Same-Level Slips, Trips, and Falls

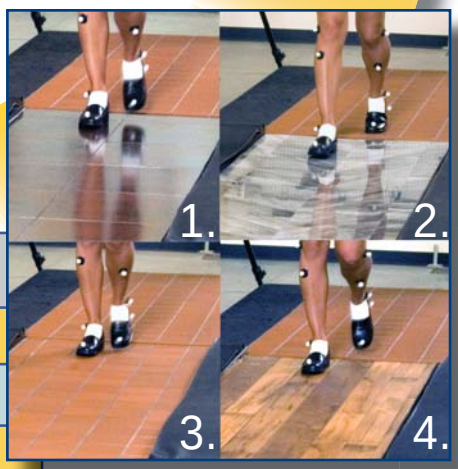
Part of understanding what can lead to a same-level slip and fall involves looking beneath the surface to examine the effects of internal and external forces on the joints, bones, and muscles during walking. By applying biomechanics, a branch of science dedicated to human movement, Liberty Mutual scientists study how various environmental and cognitive factors impact the body's response to potential slip and fall hazards.

In 2006, Liberty Mutual researchers launched a study to examine how individual perceptions of risk can impact gait adjustment. The study hypothesizes that individual visual perceptions of slipperiness and other sensory feedback received while walking can influence gait. "We know that, under certain conditions, discrepancies between perceived and actual slipperiness can hinder proper gait adjustment and increase the risk of a slip and fall," notes Chien-Chi (Max) Chang, Ph.D., principal investigator for the study. "The more we can understand the psychological causes and biomechanical effects of such discrepancies, the better our research can provide strategies to identify potentially hazardous conditions."

In an earlier related study, cognitive psychologists asked study participants to rate 38 different floor surfaces based on visual appearances. Then they examined the relationship between individual ratings of perceived slipperiness and actual measured friction for the surfaces studied. "We knew that visual cues play a critical role in shaping individual perceptions of slipperiness," notes Mary Lesch, Ph.D., cognitive psychologist and the study's principal investigator. "With this study we wanted to find out what visual cues people use to judge surface slipperiness and how well they are able to use those cues." The study found that the participants were relatively consistent in their judgments of slipperiness, and reflectance provided the strongest visual cue to perceived slipperiness.

Is It Slippery – What's Your Perception?

How would you rate the four floors (F) in the photos at right on a scale of 0 (not slippery) to 100 (extremely slippery)? Compare your answer to the slipperiness ratings (R) of our study participants and the actual measured coefficient of friction (COF). A high COF = less slippery, a low COF = more slippery.



F	R	COF	Consistency
1.	73	.76	Inconsistent - looks very slippery, but high COF
2.	90	.21	Consistent – looks very slippery, low COF
3.	29	.87	Consistent – doesn't look slippery, low COF
4.	42	.5	Inconsistent – doesn't look slippery, but relatively, low COF

Making Strides in Slips and Falls Prevention

When it comes to injuries sustained from same-level falls in the workplace, there are often two sides of the story – the perception and the reality. In 2001, Liberty Mutual conducted a workplace safety survey and found that executives rated 'falls on the same level' as the seventh most important cause of workplace accidents. However, the reality tells another story: 'falls on the same level' is the second highest category of compensable loss and cost $6.7 billion, according to the 2006 Liberty Mutual Workplace Safety Index. Further, the cost for these injuries grew more than 30 percent from 1998 to 2004.

So, why the discrepancy between the perception and reality? Employers may view slips and falls as uncontrollable or inevitable. Many are quick to cite carelessness, lack of attention, or human error as primary causes without considering other potential contributors. "It's important for employers to understand the true extent of slip and fall injuries in the workplace," says Y. Ian Noy, director of the Research Institute. "Informed employers are better equipped to direct resources towards reducing costs and providing safer environments for their workers."

The fact is, slips and falls are very complex and involve a multitude of risk factors. First, there are ergonomic-related risk factors; that is, task characteristics have a direct influence on the person's behavior in terms of movement patterns and gait, as well as the forces exerted. Then, there are factors related to how a person interacts with the walking surface. Some people may shuffle their feet, while others may lift their feet higher off the ground or have a larger stride. Another factor is age. As people age, vision is reduced, reaction time slows, and muscular strength diminishes. Consequently, the elderly tend to experience slips and falls more frequently than the younger population. Psychology also plays a role in slips and falls. For example, if a person perceives that a walking surface is slippery, that person will likely adjust his or her gait to reduce the required friction. In addition, physical factors, such as friction between the shoe sole and floor, floor contaminants, and the wear of the floor surface and shoe sole, can impact the risk of same-level slips and falls. Lastly, inadequate housekeeping, floor defects, insufficient surface roughness, poor lighting, inappropriate footwear, and transitions from one surface to another also play a critical role.

With so many underlying factors related to same-level slips and falls in the workplace, what can employers do to reduce injuries? "The organization needs to be proactive at all levels," says Wayne S. Maynard, CSP, CPE, ergonomics and tribology director with Liberty Mutual's Loss Prevention Department. According to Maynard some slips and falls without injury may go unreported because the employee is embarrassed or doesn't want to take the time to fill out an incident report. "The number of workplace slips and falls may actually be higher due to unreported accidents. When an employee doesn't report an incident, it may also set the stage for a future injury. So, it's not just management's responsibility. A proactive approach to managing slips and falls requires participation from all organizational levels."

To help employers manage occupational slips and falls, Liberty Mutual loss prevention specialists devised a practical approach based on four decades of Research Institute slips and falls research and more recent investigations in work systems design. This method requires participation at all levels of the corporate structure – organizational, group, and individual. "We simplified the socio-technical work systems model used in the work systems design research and applied it to slips and falls," states Maynard. "We also used a lot of what we've learned from Liberty Mutual's slips and falls research, including studies about perception, friction, surface roughness, and slipperiness." The resulting Slips and Falls Management Continuum (page 10) outlines 11 areas that an organization should focus on to reduce slips and falls. These include:

Management Responsibility: Senior managers who claim responsibility and set an example for slip and fall prevention have a direct, positive impact on safety. This type of proactive approach involves direct accountability for program implementation and requires a corporate commitment to funding appropriate interventions. The best floors and floor treatments, lighting, and slip-resistant footwear may cost money up front, but in the long run, they will help to reduce the higher financial burden associated with slip, trip, and fall injuries in the workplace.

Education and Training: Companies should educate all employees on the seriousness of slip and fall accidents and inform them of any hazards specific to their organization/industry. When employees know the causes of slips and falls and understand the technical components including types of flooring and types of treatments, they too can help to recognize, evaluate, and control hazards.

Hazard Surveillance: Employee incident reports and records analysis, such as workers compensation claims, and hazard surveys are excellent tools for monitoring losses and setting goals and priorities. Incident and hazard surveillance is both proactive and reactive. The former includes inspections, observations, and employee interviews, whereas reactive surveillance includes analysis of past injuries. Both are essential components of safety management.

Incident and Injury Reports: It is important to promptly report all slips and falls that occur with, or without, injury. Slip and trip hazards can be very dynamic and need to be corrected as soon as possible. Reporting all incidents, even close calls, can provide very useful information on hazards and prevention needs.

Floor Surface Selection: The most important strategy for reducing same-level slips and falls is to install an appropriate floor surface right from the start. Facility owners, designers, and others involved in real estate decisions need to understand the importance of floor selection. It is not just about cost or aesthetics. The right floor for the right environment means the floor offers optimum slip-resistant qualities and is durable in high-traffic areas. A few considerations for floor surface selection include: What kinds of spills are likely? What are the sanitary requirements? Will the area have heavy traffic? Is it normally a wet environment? How will the floor be cleaned? Are aesthetic effects a concern?

Floor Surface Treatments: For pre-existing floors, employers should evaluate the surface to determine whether the slip-resistant qualities match the environment. Floors that are inappropriate for an environment need replacement; however, new floors are often costly. If replacement is not feasible, floor surface treatments may help to improve slip resistance. Surface treatments include abrasive floor coatings, chemical etching, carpeting, and slip resistant floor cleaners and polishes.

Housekeeping and Maintenance: Many same-level falls are the result of slipperiness caused by faulty housekeeping or defects of the floor surface. When dirt or grease fills the floor surface pores or valleys, surface roughness is compromised. Cleaning protocols need to consider floor types, contaminants, and the type of cleaning solvent. Employees should adhere to floor cleaning schedules and protocols. In addition, floors should be periodically inspected for slipperiness and evaluated for effectiveness of floor cleaning protocol.

Mats: The use of mats is a valid intervention for reducing injuries. There are two types of matting systems: entrance mat systems and multi-purpose mats. Entrance mats help to keep floor surfaces clean and dry. Multi-purpose mats absorb liquids, elevate workers above standing water, provide a slip resistant working or standing surface, and/or provide anti-fatigue properties. Employers should select mats for the right environment

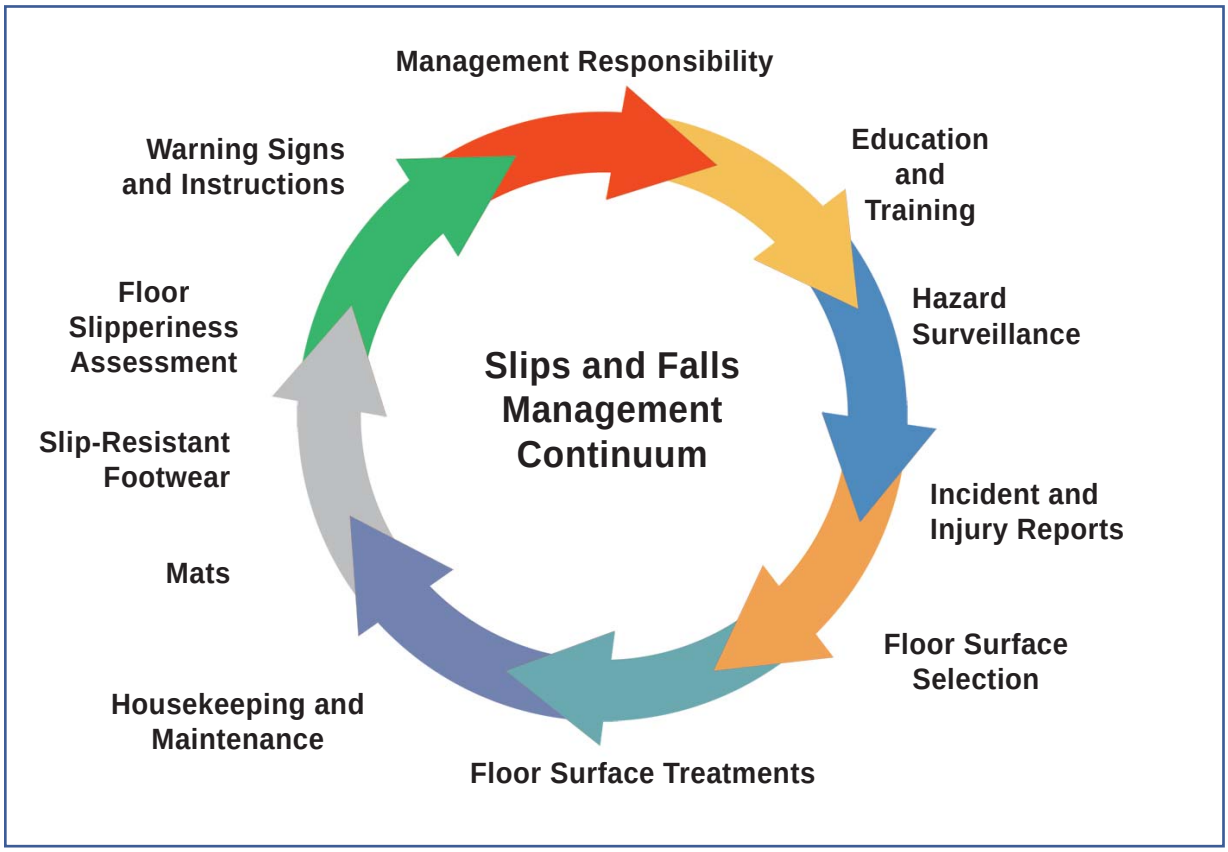
and the expected contaminants. Secure mats to prevent movement and to ensure that they do not create a tripping hazard. Beveled or flat edges help to reduce trips. Mat systems require periodic inspections, maintenance, and replacement.

Slip Resistant Footwear: Although floor selection and maintenance are key to slips and falls prevention, slip resistant footwear may help reduce the likelihood of same-level slips and falls. Consider the working environment when selecting slip-resistant footwear. Is the floor wet or greasy? Will the employee wear the footwear indoors or outdoors? There are two major components to consider when selecting an appropriate slip resistant footwear product – tread design and tread material. Employers may consult the guidelines for slip-resistant sole design, which are produced by the Shoe and Allied Trade Research Association.

Floor Slipperiness Assessments: Periodic floor slipperiness assessments are an essential component of managing slips and falls. Not only do these assessments help to determine floor slipperiness, but they can help to evaluate the effectiveness of various solutions including floor surface materials, cleaners, and treatments.

Warning Signs and Instructions: After identifying a hazard, warning signs and barricades are an effective interim solution. Warning signs should follow the guidelines established by the American National Standards Institute in 2006 - *ANSI Z535.4 Product Safety Signs and Labels*.

"Slips and falls prevention requires a strategy with goals and objectives and should be managed like other safety hazards and exposures," says Maynard. "We know the reality, and we continue to learn from the investigations at the Research Institute. One thing is clear, employers that are proactive in their approach to managing slips and falls are taking the right steps towards prevention."



NEWS

Research Institute Hosts International Slips, Trips, & Falls Conference

More than 70 government, industry, and academic representatives from seven different countries convened at the Liberty Mutual Research Institute for Safety (LMRIS) in August for the 2007 International Conference on Slips, Trips, and Falls (photo, below). The conference was the first major activity undertaken by the newly-formed International Ergonomics Association (IEA) Technical Committee on Slips, Trips, and Falls and was sponsored by the IEA, the Ergonomics Society, and LMRIS.

The conference kicked off with opening remarks from Dr. Wen-Ruey Chang, chair of the IEA Technical Committee on Slips, Trips, and Falls and LMRIS senior research scientist; Professor David C. Caple, IEA president; Dr. Roger Haslam, Ergonomics Society president; and Dr. Y. Ian Noy, Liberty Mutual Group vice president and director of LMRIS. Following the introductory remarks, attendees participated in a total of seven sessions spanning the course of the two-day event. Sessions addressed five major topic areas: injury prevention, biomechanics, tribology, accident analysis, and perception. Within each session, selected speakers presented on specific issues addressing a broad range of slips, trips, and falls research issues related to their respective areas of expertise. Session chairs included Dr. Sylvie Leclercq, Institut National de Recherche et de Sécurité, France; Dr. Chien-Chi (Max) Chang, LMRIS; Dr. Steven Thorpe, Health and Safety Laboratory, United Kingdom; Dr. Roger Haslam, Loughborough University, United Kingdom; Dr. Raoul Grönqvist, Finnish Institute of Occupational Health; Dr. Hisao Nagata, Japan National Institute of Occupational Safety and Health, and Dr. Angela DiDomencio, LMRIS.

In conjunction with the conference, participating scientists produced 39 multidisciplinary scientific papers on a wide range of slips, trips, and falls topics related to work, home, and leisure environments. Among these papers, six address accident analysis, seven biomechanics, thirteen cover injury prevention, three discuss the role of perception in slips, trips, and falls, and ten papers address tribology. “The diversity of topics covered reflects the complexity of slip, trip, and fall incidents and reinforces the fact that we have much to learn about their causes,” notes Chang. “In addition, the papers help to identify challenges, opportunities, and directions for future slips, trips, and falls research,” he adds. A special issue of *Ergonomics* is underway, which will publish a selection of papers from the conference.

“We look forward to continuing our research and cooperating with other organizations around the world to address slips, trips, and falls. This conference was unique in that its scope was narrow yet deep. It provided an important forum for scientific exchange on injury events that exact an enormous social and economic burden on society,” states Institute Director Y. Ian Noy, Ph.D.

2007 Visiting Scholar Shares Expertise on the Aging Workforce


Dr. Grosch

FACT: By 2025, the number of older workers (age 55 and up) is expected to reach 31.5 million. That is a 50 percent increase in 25 years.

For research psychologist, James Grosch, Ph.D. (right), the aging U.S. workforce is more than an interesting demographic phenomenon. It is the source of countless research opportunities aimed at helping U.S. employers improve the safety and health for this growing segment of workers. As the Institute's 2007 Visiting Scholar, Dr. Grosch shared his enthusiasm, expertise, and extensive knowledge of the subject, during a three-month collaborative exchange at the Liberty Mutual Research Institute for Safety.

On leave from his regular research post at the National Institute for Occupational Safety and Health (NIOSH), Dr. Grosch collaborated with Institute researchers to analyze occupational health and safety data from various sources, including the Health and Retirement Study (produced by the Institute of Social Research, University of Michigan), the Research Institute's 2001 study of New Hampshire Older Workers and Work Injury, and Liberty Mutual claims data. The analyses were part of a larger project that focuses on the health and safety needs of high-risk older workers.

Dr. Grosch worked with Institute scientists to analyze employment outcomes of older workers from a broad base of occupations, working conditions, and health situations. Researchers also examined individual and organizational factors and practices that may predict or contribute to positive safety outcomes for high-risk older workers. Ultimately, the information gained from these and related analyses will help to develop recommendations for workplace policies and practices designed to promote the safety and health of this group of workers. Dr. Grosch will continue to work with Institute researchers over the coming months to complete these analyses.

"It's really been a pleasure being here and seeing how Liberty Mutual runs its research program," says Dr. Grosch, who notes that he is particularly impressed by the level of interaction and discussion between disciplines. "There is truly a spirit of cooperation despite the diverse nature of the research being conducted here. I look forward to continued collaboration with Institute scientists to increase our mutual understanding of the issues facing high-risk older workers."

Dr. Grosch joined NIOSH in 1995, after having completed a one-year, post-doctoral research fellowship in occupational health at Wayne University in Detroit, Michigan. Prior to that he held research and teaching positions in the psychology departments at Colgate University, Hamilton, New York, and the State University of New York at Geneseo. His written work includes approximately 25 journal articles and book chapters, and he has contributed to several NIOSH technical publications. He is a member of the American Psychological Association, American Public Health Association, and the Society for Industrial and Organizational Psychology. Dr. Grosch earned his Ph.D. in Psychology and M.B.A. at the University of New Hampshire.

Research Institute Hosts IEA Council

LMRIS was pleased to host this year's meeting of the Executive Committee and Council of the International Ergonomics Association (IEA). The IEA is the federation of ergonomics and human factors societies from around the world. Its mission is to advance ergonomics science and practice and to improve quality of life by expanding its scope of application and contribution to society. The Council comprises representatives from 43 societies.


Members of the IEA Executive Committee from left to right: Prof. Sheng Wang, chair, IEA 2009 Congress; Prof. Min Chung, IEA treasurer; Dr. Ian Noy, director, LMRIS and IEA past-president; Prof. Pascale Carayon, IEA secretary-general; Dr. David Caple, IEA president; Prof. Marcelo Soares, chair, International Committee; Prof. Pierre Falzon, IEA immediate past-president; Dr. Halimahtun Khalid, chair, Science, Technology and Practice Committee; and Prof. Kan Zhang, Chinese Ergonomics Society.

Dempsey Named Ergonomics Society Fellow

Principal Research Scientist Patrick G. Dempsey, Ph.D., C.P.E., was recently elected as a Fellow of the Ergonomics Society (U.K.). The Fellowship recognizes significant contributions to the practice of, teaching of, and/or research in ergonomics for at least 10 years, including five years of senior professional responsibility.

A member of the Research Institute staff since 1996, Dr. Dempsey has conducted laboratory and field studies of work-related low back disorders associated with manual materials handling, as well as investigations of the factors associated with safe and productive hand tool use. Throughout his career, he has made significant contributions in the areas of applied ergonomics and musculoskeletal research. His published work includes more than 100 papers. In addition to his scientific research, he has served on the editorial board of the *International Journal of Industrial Ergonomics* and as a scientific editor for *Applied Ergonomics*. An ad hoc reviewer for numerous journals and granting agencies, he has been guest editor/co-editor of four special journal issues in the field of ergonomics.

"It is truly an honor to be recognized as a Fellow," says Dempsey. "The Ergonomics Society is one of the oldest professional organizations for ergonomists and has a world-class distinction. I am proud to be among some of the most respected professionals in the field."


Dr. Dempsey

Dr. Dempsey received his B.S. degree in industrial engineering from the State University of New York at Buffalo, and completed his M.S. and Ph.D. degrees in industrial engineering at Texas Tech University. In addition to being an Ergonomics Society Fellow, he is a member of the American Society of Biomechanics, the Human Factors and Ergonomics Society, a senior member of the Institute for Industrial Engineers. He is a certified professional ergonomist.

Students Complete Safety Research Fellowships

Bethany S. Taylor of Washington University (St. Louis, MO) and Joshua D. Hoffman of the University of Iowa (Iowa City, IA) received the 2007 American Society of Safety Engineers Foundations (ASSEF)/Liberty Mutual Safety Fellowships. The students recently completed their six-week fellowships at the Research Institute.

In June, Hoffman began his collaboration with Research Scientist William J. Horrey, Ph.D., on a project entitled "How In-Vehicle Technology Affects Safety." The study aims to identify whether drivers consider the demands of the roadway when choosing to engage in non-driving related tasks, such as reading text messages or talking on the phone. For this project, the researchers used an instrumented vehicle on Liberty Mutual's test track to replicate and expand upon Hoffman's earlier study that used a driving simulator.

At the University of Iowa, Hoffman is pursuing a Ph.D. in Industrial Engineering. He is a research assistant in the University's Cognitive Systems Laboratory, where he is developing a model of driver interaction with in-vehicle information systems to support the design of adaptive driver interfaces and evaluate in-vehicle systems. He is also an ergonomist in training with Worksafe Iowa.

In September, Taylor began her collaboration with Senior Research Scientist David A. Lombardi, Ph.D. Their study aims to compare self-reported and expert observed physical work upper-extremity exposures to data from the Occupational Information Network (O*NET™), a database developed by the U.S. Department of Labor. O*NET™ is increasingly being used as a source of occupational exposures in research; however, little has been published on whether these data provide a reliable and valid estimate for use at the individual level in research studies. The independently collected data were obtained through an ongoing, prospective study of carpal tunnel syndrome that Taylor collaborated on during her doctoral work at Washington University.

At the University, Taylor is in her final year of graduate study in the Clinical Doctorate Program in Occupational Therapy. Her interests include workplace injury prevention and implementation of work modifications post-injury to minimize work disability. One of her career goals is to research, teach, and consult with industry to identify and eliminate potentially modifiable injury-related risk factors.

Applications for the 2008 ASSEF/Liberty Mutual Safety Research Fellowships are due by February 1. For more information, visit www.asse.org\foundation\research\LM_program.php.

Conferences

51st Annual Meeting of the Human Factors and Ergonomics Society: October 1 to 5, Baltimore, MD
- Limitations of Postural Stability Ratings – A.T., DiDomenico, Ph.D., C.P.E.
- Ergonomics Professionalism and President's Forum – Y.I. Noy, Ph.D.
- Research to Practice Panel: Transitioning from Academics to Industry Practice – M.M. Robertson, Ph.D., C.P.E.

IX International Forum on Primary Care Research on Low Back Pain: October 4 to 6, Palma de Mallorca, Spain
- Recurrence of Low Back Pain – Implications and Applicability of Alternative Indicators – R. Wasiak, Ph.D.
- Geographic Variation in Opioid Prescribing for Disabling Work-Related Low Back Pain – B.S. Webster, R.P.T., P.A.-C.

38th Annual Meeting of the Association of Canadian Ergonomists: October 14 to 17, Toronto, Canada
- Leveraging Diverse Aspects of Ergonomics – Y.I. Noy, Ph.D.

47th Annual Meeting of the Society of Psychophysiological Research: October 17 to 21, Savannah, GA
- Physiological Responses During Cart Pushing on Slippery and Non-Slippery Floors: A Psychophysical Study – R.V. Maikala, Ph.D.

Workers Compensation Research Group: October 26 to 27, Hopkinton, MA
- Geographic Variation in Opioid Prescribing for Acute Work-Related Low Back Pain – M. Cifuentes, M.D., M.P.H., Sc.D.
- Preliminary Findings: Reliability of Self-Reported, Expert-Rated, and O*NET™ Physical Work Exposures – B. Taylor, O.T.D.

135th Annual Meeting of the American Public Health Association: November 3 to 7, Washington, DC
- Reducing the Resource Burden of Narrative Text Classifications for Large Administrative Databases – H.L. Corns, M.S.
- Transient Risk Factors for Slips, Trips, and Falls: A Case-Crossover Study of U.S. Health Care Workers – D.A. Lombardi, Ph.D.
- Circumstances of Occupational Same-Level Falls and Risk of Hip Fracture in Women Over 45 Years of Age Who Fell at Work – S.K. Verma, M.P.H, M.B.B.S.

Agriculture Ergonomics Development Conference: November 26 to 29, Kuala Lumpur, Malaysia
- Injury Surveillance in Vietnam Agriculture Sector: Towards a Model of Occupational Injury Burden in Southeast Asia – Y.I. Noy, Ph.D.

Conference on Education of Human Factors in China: December 10 to 12, Beijing, China
- Road Safety – Y.I. Noy, Ph.D.

Publications

Atlas, S.J., Tosteson, T.D., Hanscom, B., Blood, E.A., Pransky, G.S., Abdu, W.A., Andersson, G.B., and Weinstein, J.N., "What is Different About Workers Compensation Patients? Socioeconomic Correlates of Disability Status Among Patients With Lumbar Radiculopathy," *Spine*, Vol. 32, No. 18, pp. 2019-2026, 2007

Dempsey, P.G., "Effectiveness of Ergonomics Interventions to Prevent Musculoskeletal Disorders: Beware of What You Ask," *International Journal of Industrial Ergonomics*, Vol. 37, pp. 169-173, 2007

Harrold, L.R., Savageau, J.A., Pransky, G.S., and Benjamin, K., "Understanding the Role of Gender in Work Injuries: Implications for Primary Care Practice," *Disability and Rehabilitation*, Vol. 26, pp. 1-8, 2007

Horrey, W.J. and Simons, D.J., "Examining Cognitive Interference and Adaptive Safety Behaviors in Tactical Vehicle Control," *Ergonomics*, Vol. 50, No. 8, pp. 1340-1350, 2007

Lombardi, D.A., Sorock, G.S., Holander, L., and Mittleman, M.A., "A Case-Crossover Study of Transient Risk Factors for Occupational Hand Trauma by Gender," *Journal of Occupational and Environmental Hygiene*, Vol. 4, pp. 790-797, 2007

Shaw, W.S., Pransky, G.S., Patterson, W., Linton, S.J., and Winters, T., "Patient Clusters in Acute Low Back Pain Based on Disability Risk Factors," *Journal of Occupational and Environmental Medicine*, Vol. 49, No. 2, pp. 185-193, 2007

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Verma, S.K., Sorock, G.S., Pransky, G.S., Courtney, T.K., and Smith, G.S., "Occupational Physical Demands and Same-Level Falls Resulting in Fracture in Female Workers: An Analysis of Workers' Compensation Claims," *Injury Prevention*, Vol. 13, pp. 32-36, 2007

Wasiak, R., Kim, J.Y., and Pransky, G.S., "The Association Between Timing and Duration of Chiropractic Care in Work-Related Low Back Pain and Work-Disability Outcomes," *Journal of Occupational and Environmental Medicine*, Vol. 49, No. 10, pp. 1124-1134, 2007

Webster, B.S., Verma, S.K., and Gatchel, R., "Relationship Between Early Opioid Prescribing for Acute Occupational Low Back Pain and Disability Duration, Medical Costs, Subsequent Surgery and Late Opioid Use," *Spine*, Vol. 32, No. 19, pp. 2127-2132, 2007

A Message from the Director...

Dear Readers,

Y. Ian Noy, Ph.D.
Vice President and Director

It only took a split second. I was walking across a parking lot when I unexpectedly hit a patch of ice, slipped, and fell backwards onto the cement. Despite the force of the fall, I was lucky and did not sustain any serious injuries. Ironically, this event occurred just a few weeks after joining the Institute, where researchers have studied slips, trips, and falls for more than 40 years. The fact is, everyone is touched by the problem of slips, trips, and falls. Whether on the job, at home, or elsewhere, slip, trip, and fall hazards are a part of everyday life.

This issue profiles the Research Institute's unique, multidisciplinary approach to the study of same-level slips, trips, and falls. With experts in tribology, biomechanics, psychology, and epidemiology, our diverse research staff studies the underlying mechanisms and potential contributors to slips, trips, and falls from various scientific angles. The goal is for our research findings to be used as the basis for practical interventions and strategies to reduce slip-, trip-, and fall related injuries at work, at home, and elsewhere.

The news section features several recent events and collaborations, including the first International Ergonomics Association Conference on Slips, Trips, and Falls. We are proud to have hosted more than 200 scientists from around the world over the summer months. By continuing to provide opportunities for scientific exchange and research dissemination, we reaffirm our dedication to advancing safety research in the U.S. and abroad.

from Research to Reality

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From Research to Reality™ is a publication of the Liberty Mutual Research Institute for Safety, an internationally recognized occupational safety and health research facility. Through its broad-based investigations, the Institute seeks to advance scientific, business-relevant knowledge in workplace and highway safety and work disability. The Institute's findings are published in the open, peer-reviewed literature and often serve as the basis for recommendations, guidelines, and interventions used by industry to help reduce workplace injury and related disability.

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