reducing disability payments to severely injured workers, however, would be an unpalatable choice for most Americans. The apparent effect of the project's broad safety program in reducing the proportion of expensive claims suggests that prevention efforts can reduce not only rates, but severity, of injury. Prevention may have greater promise for reducing costs than would focusing on medical services or return-to-work- programs.

Session: F1.0
Title: Biomechanics of Slips and Falls
Category: Special Session
Organized by Raoul Gronqvist, Liberty Mutual Research Center for Safety and Health
Moderator(s): Raoul Gronqvist

F1.1 Adjustments in Gait Biomechanics on Potentially Slippery Floors—Cham R, Redfern MS

In the workplace, unexpected slippery surfaces are often the cause of fall accidents. Findings of well-controlled gait experiments on slippery surfaces have been used to investigate slip and fall biomechanics, design "safe" foot/floor interfaces and develop slip resistance testers. However, in laboratory settings, it is quite challenging to reproduce the unexpected nature of slipping accidents. The purpose of this study was to quantify the changes in gait biomechanics when subjects anticipate a possible slippery environment and investigate whether gait returns to baseline characteristics after a contaminated trial. Foot forces and body dynamics of sixteen subjects walking on three dry surfaces (vinyl, smooth painted and rough painted plywood) of varying inclination (level, 5^0 and 10^0) were recorded at 350 Hz. Gait biomechanics were compared among baseline trials (dry conditions), anticipation dry trials with a possibility of contaminant conditions (water, soap or oil) and recovery trials (recorded after a contaminated trial). Subjects were asked to walk as naturally as possible throughout testing even though there may be a contaminant condition. A within-subject repeated measures ANOVA of the trial type (baseline, anticipation, recovery) influence and flooring effect on specific gait parameters was performed within each ramp angle condition. Anticipation trials produced peak required coefficient of friction values (RCOF) that were on average 16 to 33% significantly lower than those collected during baseline trials. During recovery trials, peak RCOFs did not return to baseline values (5-12% lower). Thus, subjects reduce slip probability on potentially contaminated floors. This reduction was achieved by adopting postural and temporal gait changes resulting in ground reaction forces decreases. In addition, as a result of these adaptations, anticipation of slippery surfaces led to significant reductions in lower extremity joint torques (particularly at the knee and hip), thus decreasing the strength requirements of walking.

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F1.2 Safety on Stairs: Biomechanical and Visual Factors—Cavanagh PR, Owens DA, Startzell JK, Christina KA, Okita N, and Milner CE

Locomotion on stairs is among the most challenging and hazardous activities of daily living for elderly individuals. The demands that stairs place on the musculoskeletal and cardiovascular systems are compounded by the need for input from the somatosensory, visual, and vestibular systems at various stages in the task. Many of these collaborating systems deteriorate with aging, thus increasing the difficulty and risk of failure in a task that inherently involves exposure to significant danger. The task itself varies in its degree of challenge depending on many structural and environmental factors which are outside the control of the stair user. In this paper we will present a summary of results from several studies using the instrumented stair laboratory at Penn State. We will examine the interaction of the foot with the contact stair, clearance of the swinging foot over the stair, and the dependence of these measures on vision. We will also present preliminary data on stair descent strategies in individuals with osteoarthritis of the knee joint.

In normal visual conditions, our results indicate that, in healthy individuals, there is a progressive refinement of the stair clearance height during descent. Without vision, clearance is increased in magnitude and does not change during descent. Foot placement is also more conservative on all stairs. The ground reaction force profiles during descent are quite different when compared to overground walking, and demonstrate distinct differences depending on stair location. The frictional requirements during descent are similar to those found in level walking at the touchdown phase, but are typically less than level walking during the push-off phase. Greater frictional demands are present during the transition phase of stair descent, when compared to the mid-stair region. Joint disease increases the difficulty of stair descent, and often results in a "step-to" rather than "step-over-step" gait pattern.

F1.3 Slip Potentials During Load Carrying—Redfern MS, Cham R

The peak required coefficient of friction (RCOF), defined as the peak ratio of shear to normal foot forces, has been used to assess the frictional requirements of walking and related to slip potential. Although carrying loads is a common industrial task, few studies have investigated the effect of external loads on gait biomechanics relevant to slips and falls. The purpose of this study was to examine the effect of carrying (2-handed method) on gait biomechanics relevant to slips/falls on both level and inclined surfaces. The experimental conditions included three ramp angles (0^0, 5^0, 10^0) and three load carrying levels (0, 2.3 kg, 6.8 kg). Both body motion and foot forces were recorded at 350 Hz. The relationship between load carrying and gait biomechanics

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ABSTRACTS

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