WHOLE BODY LOCOMOTIVE BIOMECHANICS IN SLIPS, TRIP AND FALLS.

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INTRODUCTION

Slips, trips and falls continue to be a serious public health concern across the age-span. Biomechanical approaches have been used to understand the problem and reduce fall-related injuries, with some success. However, there is still much to be done. The field of biomechanics can further address the problem of slips, trips and falls and aid in further reducing the incidence of injury. This is particularly true in the workplace. The following sections describe the seriousness of the problem, with particular reference to the occupational sector. In addition, gaps in the field that need to be addressed in the future to reduce injuries are described.

EPIDEMIOLOGY OF OCCUPATIONAL SLIPS AND TRIPS

Slips are recognized as a major contributor to falls. They were the most frequent event leading to fall and overexertion related injuries in the Swedish labor force (Courtney et al. 2001) and were the most common fall initiating event for employees in the UK (Gao and Abeysekera 2004). The US National Health Interview Survey questionnaire administered by the National Center for Health Statistics in 1997 revealed a clear majority (64%) of work-related falls were attributable to slipping, tripping, or stumbling and indicated that 43% of occupational same-level fatal falls were most commonly triggered by a slip (Courtney et al. 2001). According to the Bureau of Labor Statistics (2003), nearly 30% (28.7%) of workers that sustained injuries from slips and/or falls missed 31 days of work or more. Further, 14% of accidental deaths in the workplace were reportedly caused by falls (BLS 2004). In addition to the risk of fall related injuries and fatalities, slip recovery efforts have been shown to contribute to high rates of overexertion injuries (Courtney and Webster 2001). De Laet and Pols (2000) estimated that the annual direct cost of all fall-related occupational injuries in the U.S. alone was approximately six billion dollars.

The risk of fall accidents increases with age. A 10-fold increase in the incidence of falls was reported in older adults (65+) compared to younger individuals (16-64) (Thomas and Brennan 2000) and Lloyd and Stevenson (1992) indicated that while slips and trips caused 32% of falls for young people, 67% of falls for the elderly were initiated by slips. Falls on the same level caused roughly 20% of all injuries to older workers as compared to around 10% for the general population with “floor and ground surfaces” listed as the most common source of non-fatal injuries among workers in the 55 year and older age group (Personick and Windau 1995). In 2004, over one third (39%) of the occupational fatal fall victims were 55 and older (BLS 2005), more than double that age group’s share of the work force (16%) (BLS 2005).
ERGONOMICS AND BIOMECHANICS

An ergonomics approach to reducing injuries due to slips, trips and falls is appropriate; namely, investigate the interface between the person and the environment. The principal environmental factors here are floors, shoes, contaminants, visual affordances, lighting, handrails, ramps, ladders, and steps. Human factors that are involved include postural control, motor coordination, vision, proprioception, vestibular function, and strength. Even cognitive variables, specifically attention, play an important role. However, the interactions between the human factors and environmental factors are critical.

Biomechanics has proven very useful in addressing falls from an ergonomics approach. For example, slip potentials during walking, load carrying, and other tasks have been evaluated using force plates by comparing the generated ground reaction forces to the coefficient of friction of the shoe/floor/contaminant interface. This has led to improvements in the design of workplace flooring to maintain adequate friction. Other studies have used whole-body dynamics analysis to investigate stability during various work-related tasks, leading to redesign of jobs or environments.

FUTURE APPLICATIONS

There are a number of areas where biomechanical approaches can continue to lead to reductions of injuries due to occupational falls. The following are some specific applications:

Slip potentials during work: Understanding the frictional requirements for various tasks in the workplace will lead to improvements in the selection of floors and shoes towards the reduction of slips and falls.

Ladders, Ramps, and Steps: There is limited understanding of the biomechanical implications of these designs with respect to falls. Further study of the interface of the worker and these environments is needed.

Population-specific studies: Biomechanical studies of special populations are necessary to understand specific design needs to reduce injuries. The older adult population is one group in particular where studies will yield knowledge necessary to make modifications to the environment to reduce age-related falls in the workplace.

Human/environmental factor interactions: The previously mentioned human factors interact with environmental factors to impact the biomechanics of locomotion and task performance. Research into these effects will result in new designs to reduce high fall risk situations.

REFERENCES

Courtney, T and Webster, B (2001), J. AIHA, 62, 622-632,
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