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Non-fatal occupational falls on the same level

Han T. Yeoh [a], Thurmon E. Lockhart [a] & Xuefang Wu [a]
[a] Locomotion Research Laboratory, Grado Department of Industrial and Systems Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA
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Han T. Yeoh, Thurmon E. Lockhart* and Xuefang Wu

Locomotion Research Laboratory, Grado Department of Industrial and Systems Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA

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The purpose of this study was to describe antecedents and characteristics of same level fall injuries. Fall incidents and costs were compiled from the Bureau of Labor Statistics and other sources from 2006–2010. This study indicated that over 29% of 'fall on same level' injuries resulted in 31 or more workdays lost. The major source of injury was 'floors, walkways or ground surfaces', and the most affected body parts were the lower extremities and the trunk. With regard to gender and age, female workers had the highest risk of falls, while advancing age coincided with an increase in incidence rates. Overall, workers in the healthcare and social assistance industry, the transportation and warehousing industry, and the accommodation and food services industry had the highest risk for 'fall on same level' injuries. Furthermore, the overall compensation cost increased by 25% from 2006–2009. Along with existing evidence, these results may facilitate the design and implementation of preventative measures in the workplace and potentially reduce fall-related compensation costs.

Practitioner Summary: This research presents a unique and detailed analysis of non-fatal 'fall on same level' injuries in a large population of workers from various private industries in the USA. This information can be used to prioritise designing and implementing preventive measures and to provide workers with the understanding of risk factors associated with falls in the workplace.

Keywords: falls; fall on same level; occupational injuries; characteristic of injured workers; consequences of occupational fall

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Introduction

Injuries associated with fall accidents pose a considerable threat to the USA in terms of both human suffering and economic losses. According to the Bureau of Labor Statistics (BLS), the three most frequent fatal injuries are highway incidents, falls and homicide (BLS 2010a). Approximately, 9 out of 10 non-fatal occupational injuries result from three events: bodily reaction and exertion, contact with objects and equipment, and 'fall on same level' (BLS 2008). For the first time in the history of the industrialised world, the combined cost of all fall-related occupational injuries surpassed overexertion injuries caused by excessive lifting, pushing, pulling, holding or throwing an object with a significant burden on our economic system (National Safety Council 2006) and are responsible for a significant proportion of worker absenteeism (Courtney et al. 2001; Courtney and Webster 2001). The annual direct cost of occupational injuries due to falls in the USA is expected to exceed $43.8 billion by the year 2020 (Englander, Hodson, and Terregrossa 1996).

Although the elements behind occupational fall accidents are not yet fully understood, a number of demographic, lifestyle and workplace factors have been linked with risk of injury in an occupational accident (Swaen et al. 2004; Laflamme, Menckel, and Lundholm 1996; Chipman 1995; Frone 1998; Wells and Macdonald 1999; Leistikow et al. 2000; Frank 2000; Nag and Patel 1998). Successful interventions for reducing falls require a comprehensive knowledge of the mechanisms involved. This study describes the characteristics of occupational fall accidents, the initiating events and the final outcome leading to injury and disability. Moreover, because of the growth trends in occupational 'fall on same level' incidents, the non-fatal occupational injury category related to this event is of particular interest. Hence, the objective is to describe occupational 'fall on same level' injuries in US private industries, categorised by the following factors: major US industry, nature of injury, source of injury, types of exposures or events, part of body injured, occupation, age of injured, gender of injured, the number of days away from work (DAFW) due to fall related injuries, time of fall occurred and, finally, the cost of these injuries.

*Corresponding author. Email: lockhart@vt.edu

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Methods

Information and costs accompanying non-fatal incidents were compiled from two sources: the US BLS and the Liberty Mutual Research Institute, Workplace Safety Index (WSI). The data we accessed are available at the BLS (2012) and Liberty Mutual Research Institute website (Liberty Mutual 2010).

The US BLS national data

The BLS compiles national data on non-fatal occupational injuries and illnesses in the private industry from the Survey of Occupational Injuries and Illness (SOII) and estimates the overall occupational injury and illness experience (BLS 2011). The BLS categorises four main events or exposures in fall-related injuries: 'fall to lower level', 'fall on same level', 'jump to lower level' and 'unspecified' events. 'Fall on same level' events occur when contact with the source of injury is made on the same level or above the surface supporting the injured person. 'Fall to lower level' events transpire when the source of injury makes contact below the surface level supporting the individual. Conversely, 'jump to lower level' events arise when the injured person voluntarily leaps from an elevation, albeit to avoid an uncontrolled fall or other injury. Events peripheral to these categories are labelled 'Unspecified'. To estimate the impact of 'fall on same level', and consequently overall occupational fall injuries in the US, 'slip, trip, loss of balance without fall' injuries were also included. 'Slip, trip, loss of balance without fall' injuries were classified under the bodily reaction event category, where a worker slipped, stumbled, mis-stepped but did not fall. (The title was switched to OIICS 2.0 after the coding structure underwent a comprehensive revision in 2010. Under this new structure, the BLS moved 'slip, trip, loss of balance without fall' events out of the overexertion category and into a new category titled, 'slips, trips and falls'.) 'Slip, trip, loss of balance without fall' was estimated by using BLS' yearly tables entitled 'Table R4'.

Non-fatal injuries and illness-related work absences are classified by nature, source, injured body part, age, gender, occupation, race, time when injury occurred and length of service involving one or more DAFW. Agricultural establishments with fewer than 11 employees, self-employed individuals and federal government employees are excluded from the survey. This study is a compendium of fall-related injury data based on the SOII, between the years 2006 and 2010. The BLS tables were examined to extract physiologically meaningful injury statistics relevant to occupational falls and to provide the number of incidence, percentage (%) and incidence rate, where incidence rate embodies the number of injuries per 10,000 full-time workers. Specifically, the number of cases and per cent distribution of fall injuries involving DAFW were extracted from the BLS yearly supplemental table entitled 'TABLE 3 Number, percent distribution, and median days away from work for nonfatal occupational injuries and illnesses involving days away from work by selected worker and case characteristics and falls.' Incidence rates for 'fall on same level' injury, part of body, source, occupation, age group and gender were estimated from tables R8, R24, R30, R100, R110 and R111, respectively, for each studied year. Furthermore, per cent distribution of number of DAFW, time of day injury occurred and affected industry were mined from tables R70, R90 and R113, respectively.

The Liberty Mutual Research Institute worker compensation data

The worker compensation costs of fall-related injuries were derived using the Liberty Mutual Research Institute, WSI. The WSI consolidates serious non-fatal workplace injuries and identifies the explicit causes behind the events. WSI was developed by applying annual Liberty Mutual workers' compensation claims cost data to the workplace accident frequency information provided by the US Department of Labor's Bureau of Labor Statistics. The data were then applied to national estimates of the cost of workers' compensation benefits from The National Academy of Social Insurance, which includes information from a broad range of workers' compensation insurance companies. Using injury event definitions developed by the BLS, the Liberty Mutual Research Institute amasses injury data associated with employees missing 6 or more days from work, and ranks them by total worker compensation costs (Liberty Mutual 2010). The information obtained from BLS tables were used in conjunction with the workers' compensation cost to identify as many specific details as possible about the circumstance of 'fall on same level' events to further delineate conditions that might have contributed to these injuries.

Results

Table 1 specifies the 5-year period from 2006 to 2010, where approximately 5.32 million work-related non-fatal injuries involving DAFW occurred in the USA; $>$ 21.6% (1.14 million) of these accompanied falls. Subsequently, 'slip, trip, loss of balance without fall' induced 170,270 injuries, contributing to around 3.2% of overall annual private industry injuries. The percentage of fall-related injuries classified by four main events involving DAFW from 2006 to 2010 is illustrated in Figure 1. Table 2 encompasses occupational injuries, overall fall injuries and fall-related injuries involving DAFW in the

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Table 1. Number, percentage and incidence rate of occupational injuries involving DAFW by selected events in private industry for all United States, 2006–2010.

	All events	All fall[a]			Fall on same level			Slip or trip without fall		
Year	Number	Number	Percentage[b]	Incidence rate[c]	Number	Percentage[b]	Incidence rate[c]	Number	Percentage[b]	Incidence rate[c]
2006	1,183,500	234,450	19.8	25.3	151,750	12.8	16.4	35,440	3.0	3.8
2007	1,158,870	253,440	21.9	26.7	166,560	14.4	17.6	37,780	3.3	4.0
2008	1,078,140	234,840	21.8	24.7	157,680	14.6	16.6	35,420	3.3	3.7
2009	964,990	212,760	22.0	23.4	141,120	14.6	15.6	32,490	3.4	3.6
20010	933,200	208,470	22.3	24.1	139,660	15.0	16.1	29,140	3.1	3.4

Source: Bureau of Labor Statistics (2012).
[a] Includes fall to lower level, fall on same level and jump to lower level.
[b] Percentage of overall non-fatal occupational injuries in private sectors.
[c] The number of injuries per 10,000 workers.

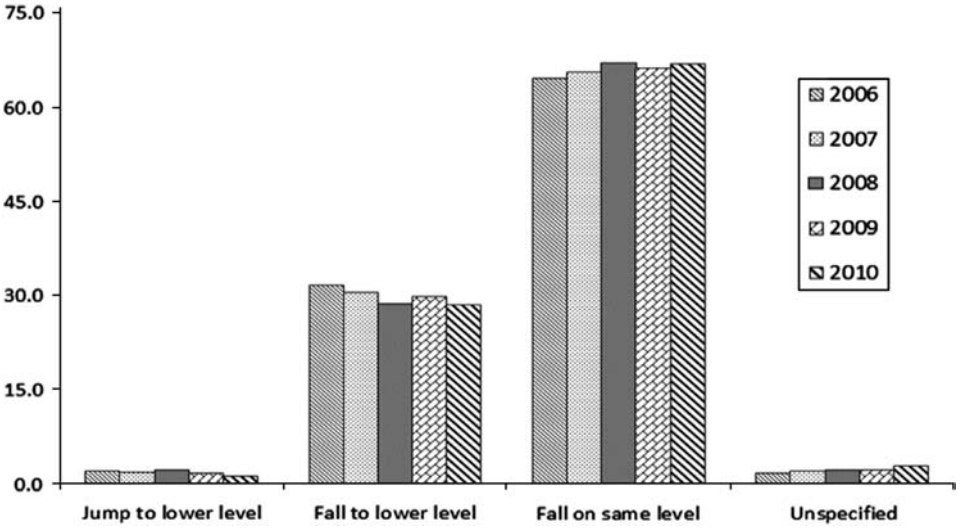

Figure 1. Percentage of occupational injuries by fall-related events in private industry. *Source*: Bureau of Labor Statistics (2012).

Table 2. Number, percentage and incidence rate of occupational injuries involving DAFW by falls in private industry, 2006–2010.

	All fall[a]	Fall on same level			Fall to lower level			Jump to lower level		
Year	Number	Number	Percentage[b]	Incidence rate[c]	Number	Percentage[b]	Incidence rate[c]	Number	Percentage[b]	Incidence rate[c]
2006	234,450	151,750	64.7	16.4	74,280	31.7	8.0	4590	2.0	0.5
2007	253,440	166,560	65.7	17.6	77,300	30.5	8.1	4560	1.8	0.5
2008	234,840	157,680	67.1	16.6	67,510	28.7	7.1	4830	2.1	0.5
2009	212,760	141,120	66.3	15.6	63,320	29.8	7.0	3670	1.7	0.4
2010	208,470	139,660	67.0	16.1	59,440	28.5	6.9	2580	1.2	0.3

Note: Slip or trip without fall data are not included, incidence rate embodies the number of injuries per 10,000 full-time workers.
Source: Bureau of Labor Statistics (2012).
[a] Includes fall to lower level, fall on same level and jump to lower level.
[b] Percentage of non-fatal occupational fall injuries in private sectors.
[c] The number of injuries per 10,000 workers.

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private industry. Among the fall events, 'fall on same level' cases correlated with the most fall-related injuries, including an average of 66.2% of total occupational falls. 'Fall to lower level' cases were a distant second, with an average of 29.8%. Workers during this period were two times more at risk of 'fall on same level' injuries than 'fall to lower level' injuries, with an average incident rate of 16.5–7.4 over the 5-year period.

Table 3(A) shows that female workers experienced a greater distribution of 'fall on same level' injuries involving DAFW compared to their male counterparts (55.7% female; 44.3% male). In particular, female employees were two times more at risk than male employees over the 5-year period, with incidence rates of 22.0 and 12.5, respectively. In Table 3(B) workers between 45 and 54 years of age had the most fall-related injuries involving DAFW, with an average of 27.2%. The 55–64 and 35–44 age groups were the second and third largest fall populations with an average of 21% and 20.3%, respectively. The combination of these groups, ages 45–64 years, gave a total of 48.2% injuries associated with 'fall on same level' accidents and indicates that the incidence rate of falls increases with advancing age. The incidence rate for falls was highest among persons of 65 years and older with 34 falls per 10,000 workers, compared to the younger age group of

Table 3. Characteristics of injured workers – same level falls involving DAFW in private industry, 2006–2010.

	2006		2007		2008		2009		2010	
Characteristics of injured workers	Percentage	Rate	Percentage	Rate	Percentage	Rate	Percentage	Rate	Percentage	Rate
(A) Gender										
Women	54.1	21.6	53.9	23.1	56.8	22.6	56.7	20.8	57.1	21.7
Men	45.9	12.8	46.1	13.8	43.2	12.3	43.3	11.7	42.8	12.1
(B) Age group (years)										
16–19	2.8	14.3	2.5	14.4	2.5	14.3	1.9	12.1	2.2	16.2
20–24	8.0	12.9	7.0	12.4	6.5	11.1	6.7	11.3	6.0	10.7
25–34	16.8	11.7	16.5	12.4	16.1	11.5	15.4	10.3	15.1	10.4
35–44	22.2	14.5	20.9	15.1	20.5	14.1	19.9	13.1	17.9	12.6
45–54	25.9	18.0	26.9	20.1	27.0	18.8	27.2	17.5	29.0	19.6
55–64	19.2	26.3	20.8	29.6	21.5	27.3	21.6	24.4	21.7	24.9
65 and over	5.2	33.1	5.5	34.6	6.0	33.7	7.2	36.1	7.0	34.6
(C) Occupation[a]										
Building and grounds cleaning and maintenance	6.6	36.4	7.1	42.2	7.0	39.4	7.9	42.4	7.2	39.7
Construction and extraction	7.8	21.5	7.2	21.5	6.1	16.9	5.5	16.8	4.8	16.8
Farming, fishing and forestry	1.0	16.6	0.8	15.1	0.7	12.4	0.9	14.0	0.9	14.1
Food preparation and serving	11.5	24.8	10.2	23.8	9.8	21.4	9.9	19.8	10.9	22.0
Office and administrative	10.1	10	10.5	11.1	11.5	11.5	9.8	9.2	10.4	10.2
Healthcare support	6.3	39.1	6.7	43.6	7.3	42.4	8.4	42.8	8.0	40.6
Installation, maintenance and repair	4.4	15.0	4.8	17.6	4.8	16.9	5.1	16.9	5.0	17.4
Production	9.6	16.1	9.4	17.2	9.0	16.1	7.8	14.1	8.4	16.3
Protective service	1.3	22.7	1.5	27.6	1.6	28.0	1.6	24.0	1.3	21.2
Sales	9.0	12.6	9.5	14.3	9.5	13.4	9.4	12.4	7.9	10.8
Transportation and material moving	15.6	29.8	15.4	32.4	14.9	30.2	14.4	28.6	15.2	31.6
(D) Industry[a]										
Accommodation and food services	–	25.5	21.8	22.1	23.4	21.2	20.3	19.5	20.7	21.3
Agriculture, forestry, fishing and hunting	–	22.1	10.1	18.2	9.3	16.9	10.5	17.1	12.4	20.4
Construction	–	17.5	9.3	17.7	7.6	13.3	8.8	13.8	9.6	14.3
Healthcare and social assistance	–	27.0	20.2	29	20.4	28.5	20.7	28.6	18.9	26.5
Manufacturing	–	12.5	9.3	13.3	7.6	12.7	8.8	10.6	9.6	11.5
Mining	–	16.9	10	13.9	8.5	10.9	9.8	10.6	11.3	11.5
Retail trade	–	19.1	16.2	22.2	16.1	19.4	15.2	18	14.2	16.8
Transportation and warehousing	–	28.2	11.8	31.2	11.4	27.9	10.8	24.5	12.3	28.8
(E) Length of service with employer										
< 3 months	12.6	–	12.1	–	10.4	–	7.8	–	8.5	–
3–11 months	20.5	–	19.0	–	21.1	–	16.8	–	15.2	–
1–5 years	30.9	–	32.4	–	36.3	–	37.6	–	35.7	–
> 5 years	35.6	–	35.9	–	32.0	–	37.2	–	39.5	–

Note: Slip or trip without fall data are not included.
Source: Bureau of Labor Statistics (2012).
[a] Listed in alphabetical order.

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25–34 years consisting of 11 falls per 10,000 full-time workers. The percentage of fall-related injuries among selected occupational specialities is shown in Table 3(C). Overall, workers in the transportation and material-moving occupation had the highest amount of injuries associated with 'fall on same level' events that involved DAFW, with an average of 15.1% of total falls. In addition, workers in food preparation and serving, along with the office and administration support occupation, amassed the second and third highest percentage of injuries, with 10.5% of 'fall on same level' injuries. The office and administration support occupation comprises the following major groups: switchboard operators; bill and account collectors; clerks; cargo and freight agents; police, fire and ambulance dispatchers; postal service mail carriers; computer operators. With regard to incidence rates, healthcare support workers represented the highest rate of same level occupational fall-related injuries, equalling 41.7 falls in every 10,000 workers. The cleaning and maintenance occupation of the building and grounds was a close second with 40 falls, followed by the transportation and material-moving occupation with 30.5 falls.

Table 3(D) lists the types of industries frequently involved in 'fall on same level' injuries involving DAFW. The accommodation and food services industry has the highest number of falls with an average of 21.6% over the past 5 years, followed closely by the healthcare and social assistance industry with 20.1%; the retail trade industry with 15.4%. Figure 2 illustrates the incidence rate of the affected industries in 'fall on same level' related injuries. The workers in transportation and warehousing sector are at high risk of falls with an average of 28.1 falls in every 10,000 workers. Healthcare and social assistance workers are the second highest with an incidence rate of 27.9 falls per 10,000 workers. The industries such as accommodation and food services (incidence rate per 10,000 workers: 21.9); retail trade (19.1) and agriculture, forestry, fishing and hunting (18.9) experienced higher fall rates than the construction industry (15.3). Table 3(E) shows the length of service with the employer when the fall accident transpired. Workers exceeding a year of employment experienced >70% of fall accidents, whereas workers with under a year of employment endured considerably less (about 28.8%).

Table 4 summarises the consequences of occupational 'fall on same level' injuries involving DAFW. The lower extremities, which include the knees, feet and toes, were the most affected areas with an average of 30.7% of total fall-related injury categories. Likewise, the trunk, which encompasses both the shoulder and back, was the second most injured body part, with an average of 25.6%. The BLS uses the classification 'multiple body parts' for any injury in which body parts from two or more divisions of the body are injured. Workers with injured multiple body parts ranked third with approximately 21.8% of overall injuries (Table 4(A)). The BLS defines source of injury as 'the objects, substances, equipment, and other factors responsible for the injury or illness incurred by the worker or that precipitated the event or exposure' (US Department of Labor Bureau of Labor Statistics 2012). The sources of injuries associated with 'fall on same level' incidents are detailed in Table 4(B). Amongst these sources, the majority, i.e. 87.9%, resulted from floors, walkways or ground surfaces, while the sum of the remaining causal factors only culminated in 12.1% of injuries. Work absences as a direct result of injuries incurred on the job are presented in Table 4(C). The data show that nearly 30% of 'fall on same level' injuries resulted in a loss of 31 or more workdays.

Table 5 summarises the compensated cost for the top 10 most serious workplace injuries and 'fall on same level' related injuries. The top 10 causes of workplace injuries includes overexertion, falls on same level, bodily reaction, falls to lower

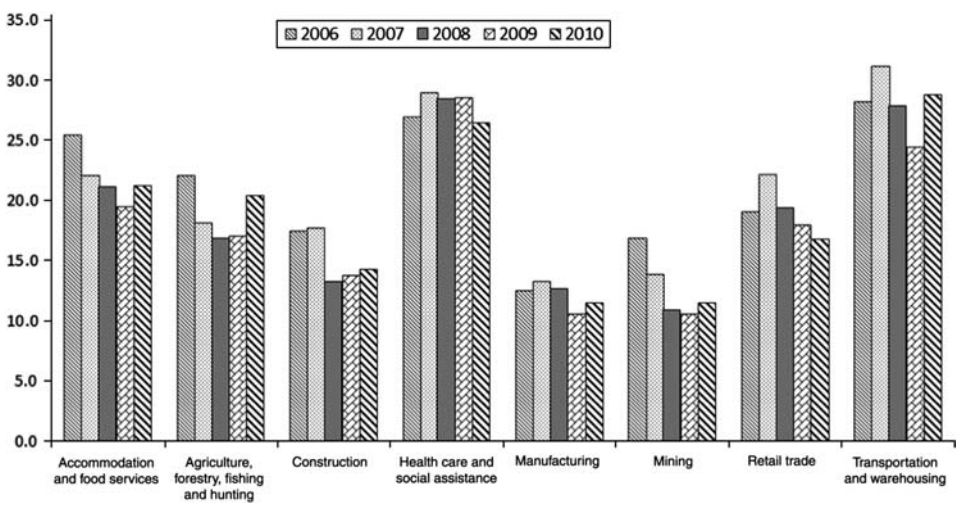

Figure 2. Number of incidences per 10,000 full-time workers for non-fatal occupational injuries in major US industries. *Source*: Bureau of Labor Statistics (2012).

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Table 4. Consequences of same level falls involving DAFW in private industry, 2006–2010.

	2006		2007		2008		2009		2010	
Consequences of falls	Percentage	Rate	Percentage	Rate	Percentage	Rate	Percentage	Rate	Percentage	Rate
(A) Part of body injured										
Head	5.1	0.8	5.4	0.9	5.2	0.9	5.8	0.9	5.3	0.9
Neck	0.6	0.1	0.6	0.1	0.8	0.1	0.5	0.1	0.5	0.1
Trunk	25.8	4.2	26.1	4.6	26.2	4.3	25.7	4.0	24.0	3.9
Upper extremities	15.5	2.5	15.5	2.7	14.9	2.5	14.7	2.3	15.6	2.5
Lower extremities	31.2	5.1	30.7	5.4	29.5	4.9	30.5	4.7	31.8	5.1
Body systems	0.1	–	0.2	–	0.1	–	0.1	–	0.2	–
Multiple	20.7	3.4	21.1	3.7	22.7	3.8	22.2	3.4	22.2	3.6
(B) Source of injury										
Furniture, fixtures	2.4	0.4	2.9	0.5	2.6	0.4	2.8	0.4	2.4	0.4
Machinery	1.2	0.2	1.7	0.3	1.1	0.2	0.9	0.1	1	0.2
Parts and materials	1.9	0.3	1.4	0.2	1.3	0.2	0.9	0.1	1.1	0.2
Floor, ground surfaces	86.9	14.2	87	15.3	88.7	14.7	88.2	13.7	88.5	14.3
Vehicles	2.1	0.3	2	0.3	2	0.3	2	0.3	1.9	0.3
(C) Number of DAFW										
1 day	11.7	–	12.7	–	12.3	–	13.2	–	12.6	–
2 days	11.1	–	11	–	10.4	–	9.9	–	11.4	–
3–5 days	17.5	–	17.8	–	16.6	–	17.6	–	17.4	–
6–10 days	12.5	–	11.5	–	12.2	–	11.3	–	10.8	–
11–20 days	10.9	–	11.6	–	12	–	11.4	–	11.2	–
21–30 days	7.5	–	6.9	–	7.8	–	6.4	–	6.2	–
31 or more days	28.8	–	28.6	–	28.7	–	30.2	–	30.5	–

Note: Slip or trip without fall data are not included.
Source: Bureau of Labor Statistics (2012).

Table 5. Compensated cost for top 10 major occupational injuries and 'fall on same level' related injuries.

	All events	Fall on same level	
Year	Cost ($b)	Cost ($b)	Percentage
2006	48.6	6.4	13.2
2007	53.0	7.7	14.5
2008	53.4	8.4	15.7
2009	50.1	7.9	15.8

Note: Compensation costs for injuries involving six or DAFW only.
Source: Liberty Mutual (2010).

level, struck by object, repetitive motion, highway incident and others. The results show that over the 4-year period from 2006 to 2009, compensation costs grew 25% ($6.4 billion in 2006 to $7.9 billion in 2009) for the falls on the same level injuries.

Discussion

Impact of 'fall on same level' occupational fall injuries

Although the number of overall occupational injuries involving DAFW decreased by 250,300 over the 5-year period (1,183,500 cases in 2006 to 933,200 cases in 2010), the percentage of overall fall injuries, including 'fall on same level', 'fall to lower level', 'jump to lower level' and other fall-related events, actually increased incrementally from 19.8% in 2006 to 22.3% in 2010. Furthermore, the percentage of 'fall on same level' injuries also increased in that manner from 12.8% in 2006 to 15% in 2010 (Table 1). The aforementioned decrease is likely a ramification of the high unemployment rate during this period as the unemployment rate in 2004 was a modest 5.5%, but rose to a staggering 9.3% in 2009 (BLS 2012). Thus, the injury percentage of 'fall on same level' accidents increased as it relates to overall occupational falls regardless of the unemployment rate. The results suggest that 'fall on same level' related occupational injuries contribute to $>14\%$ of overall occupational injuries, and might be higher if we consider the number of 'slip, trip, loss of balance without

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fall' related injuries involving DAFW (around 3.2% of overall annual private industry injuries) which may lead to a fall incident. The finding on the incidence rate among fall events shows that 'fall on same level' events incur more injuries than 'fall to lower level' events by more than twofold.

Characteristics of injured workers

Gender. Female workers experienced a greater distribution and incidence rate of 'fall on same level' injuries involving DAFW compared to their male counterparts. The rationale behind this can vary, but the difference in the types of occupations between the two genders might be a contributing factor. Workers in food preparation and serving, along with the office and administration support, and healthcare support contributed to >28% of 'fall on same level' related injuries, which are commonly female occupations. In addition, some believe that the task-related factors that are involved in load handling, patient lifting, rushing, risk-taking, physical exertion and complexity of task might increase the risks of fall (Gauchard et al. 2001; Lipscomb et al. 2006; Gao, Holmer, and Abeysekera 2008). Caregivers or nurses fell during patient transfers and when saving patients from a fall (Kemmlert and Lundholm 2001). Kemmlert and Lundholm (1998) also found that female healthcare workers had higher slips, trips and falls (STF) injury rates than male healthcare workers. Another factor might be pregnancy. Several studies have indicated that falls are a leading cause of maternal injury among pregnant women (Weiss, Sauber-Schatz, and Cook 2008; Schiff, Holt, and Daling 2002; Kuo et al. 2007). This is likely due to the musculoskeletal changes in a woman's body during pregnancy (i.e. increased joint and ligament laxity from hormonal changes) and shifts in the body's locus of balance from the increasing body weight and changing centre of gravity (Evenson et al. 2009; Ireland and Ott 2000; Butler et al. 2006). Furthermore, women in general are tasked with jobs that require formal wear and high heels as part of the dress code, i.e. in office and administration support occupation. With respect to shoe type, numerous safety organisations have cited high heels as a risk factor for slips and falls (Merrifield 1971; Snow and Williams 1994; Opila-Correia 1990). The correlation between high heels and increased potential for slipping suggests that the friction demand may be greater with high heels than with low heel shoes. For the purposes of this study, the results obtained here solely reflect the overall same level fall injuries related to gender and did not detail this parameter on specific industries. Previous investigations have shown that construction falls were the most prevalent for male workers, whereas most female worker falls occurred in the services industry (Bunn, Slavova, and Bathke 2007). Therefore, the result highlights the need for more research to identify work-related exposures that influence the risk of fall in female workers.

Age. The labour force of the USA is growing older. This ageing is largely credited to the population growth during the baby boom era. The average retirement age is also expected to increase, due in part to a healthier older population, declining age discrimination, and gradual increases in age for collecting full social security benefits (Dohm 2000). These demographics suggest that issues of ageing will become more prominent in occupational safety and health research of the future (Layne and Pollack 2004). This is distressing as our results reported older workers have higher rates of STF involving DAFW accidents than younger workers, as has been reported elsewhere (Laflamme and Menckel 1995; Kemmlert and Lundholm 1998; Kemmlert and Lundholm 2001). Courtney et al. (2001) for instance, reported that the incidence rate corresponding with fall-induced fatalities increased sharply at 55 years of age and subsequently peaked in workers aged 65 and older. The consistency in these results and the aforementioned investigations suggests that fall accidents among the elderly may be related to age-related deterioration in the visual, proprioceptive and vestibular signals concerning postural control (Lockhart et al. 2002; Lockhart, Woldstad, and Smith 2003).

Occupation and industry. Slips and falls have been documented elsewhere as an important source of injury in jobs such as truckers and drivers (Nicholson and David 1985). The Miller study in 1976 indicated that about one-fourth of all truck driver injuries in the USA are associated with slips and falls in and around the truck (Miller 1976). While in 1997, the bureau of motor carrier safety, Federal Highway Administration, found that 54% of truck slip and fall accidents happen on the tractor and 46% on the trailer (Federal Highway Administration 1997). Workers in food preparation and serving amassed the second highest percentage of injuries, this occupation includes cooks, food preparation workers; bartenders, waiters and waitresses; food servers and dishwashers. The results presented here are consistent with those of the previous studies in which STF are one of the most common injuries in food services (Filiaggi and Courtney 2003; Courtney, Wellman, and Filiaggi 2005; Wellman, Filiaggi, and Courtney 2005; Alamgir et al. 2007; BLS 2007). Common sources of slippery floors in restaurant environment include dishwashing overspray or run-off, leaking equipment or pipes, food debris and spillage from transport of open containers (such as those holding fryer grease and food wastes) (Filiaggi and Courtney 2003). According to the Cotnam, Chang, and Courtney (2000), the healthcare industry is the largest employer in the USA (13 million employees) and ranks second among eight industries as having the highest percentage of claim costs associated with 'falls on the same level'. Some believe that this high percentage of falls is an indicative of their work environment, i.e. floor resistance, external environmental conditions and footwear (Veazie, Landen, and Bender 1994; Bell et al. 2008;

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Bentley and Haslam 1998). In addition, the nature of the work in these occupations or industries requires load carriage, and numerous studies have reported load carrying to be associated with an abnormal gait pattern and an increased heel slip distance after heel contact, hence increasing the risk of falls (Qu and Nussbaum 2009; Zultowski and Aruin 2008; Heller, Challis, and Sharkey 2009; Schiffman et al. 2006; Kincl et al. 2002; Park et al. 2010).

Length of service. The results show that workers exceeding a year of employment experienced >70% of fall accidents involving DAFW, whereas workers with under a year of employment endured considerably less (~28.8%). These findings suggest that employers could benefit by implementing an annual training programme to employees that reinforces safety awareness to prevent employees from future fall-related injuries. For example, employers are recommended under title 30 Code of Federal Regulations Part 46.8 to provide each miner with no <8 h of annual refresher training on fall prevention and protection (US Department of Labor 2011). Although the incident rates are not available, studies elsewhere (Breslin and Smith 2006; Chau et al. 2010) have reported that workers with shorter job tenures have higher injury rates than workers with longer job tenures. For example, Chau et al. (2010) reported that the relative risk decreased steadily with increasing length of service within the company, from 2.6 for 1 year to 1.0 for >30 years in railway workers. Their findings suggest that direct experience in specific occupations is vital.

Consequences of occupational non-fatal 'fall on same level' related injuries

Part of body injured. Our study indicates that the majority of 'fall on same level' injuries involving DAFW were affiliated with the lower extremities. Similar results were obtained in other papers dealing with occupational ladder fall accidents (Cohen and Lin 1991; Cattledge et al. 1996). Although the fall accidents reported in this study are non-fatal injuries, it can still cause serious harm, such as bone fractures, back injuries, concussions or permanent disability (Courtney and Webster 2001; Courtney, Matz, and Webster 2002). The correlation between ageing and skeletal fractures, particularly female worker 'fall on same level' related injuries, cannot be underestimated as several studies have reported that women aged 45 years and above are at an increased risk of fracture due to falls (McNamee et al. 1997; Stevens and Sogolow 2005; Cherry et al. 2005).

Source of injury. Numerous countermeasures that could potentially reduce fall-related injury accidents include slip-resistant shoes, floor surfaces, mats, waxes, prompt cleaning of spillage and debris, keeping stairs and walkways clear, improving lighting, adding handrails and clearing ice and snow (Lewis 1997; Labar 1998; Morrison 1999). In 1985, Ballance et al. documented a reduction in the number of reported injury incidents involving 'falls on the same level' after replacing wood and ceramic flooring with less slippery tiles and carpet with higher coefficients of friction. Similarly, Manning et al. (1988) suggested that one of every four STF injury incidents could have been prevented by cleaning up spills and objects on the floor. Researchers have been working towards establishing safe floor resistance standards since the 1920s utilising the tribological approach (Biel 1920). Tribology deals with surface dissipative processes in terms of the hydrodynamics and viscoelastic characteristics of contaminants and the shoe–floor interface. The tribological approach to fall prevention has concentrated on setting safe static and dynamic coefficient of friction (COF) limits for ambulation (Chang et al. 2008; Redfern et al. 2001; Grönqvist et al. 2001). However, many conflicting ideas of dynamic versus static COF, lack of standard or law that requires that a floor must have certain level of slip resistance and ever-changing environmental conditions (associated with keeping the COF levels constant) hamper development in this area, and remain to be an important and critical task in the future.

Number of DAFW. Previous investigations from 1999 to 2001 only reported an average of 26.7% of injuries that culminated in 31 or more workday absences (Yoon and Lockhart 2005). This increase in DAFW suggests that the consequences of 'fall on same level' injuries are becoming more serious and that additional time is needed to recover. In addition, previous studies also suggest that older workers take longer time to return to work than their younger colleagues (Centers for Disease Control and Prevention 2011; Butler, Johnson, and Baldwin 1995; Rogers and Wiatrowski 2005), and that an increasing number of Americans have already begun delaying retirement to work longer. For example, between 1993 and 2009, labour force participation rates in the age group of 65–69 years increased from 25% to 36% for men and from 16% to 27% for women (BLS 2010b); furthermore, workers in the 55 years and older age group are projected to increase from 17% in 2006 to nearly 23% by 2016 (Toossi 2007; Garr 2009; Musich, McDonald, and Chapman 2009). We believe that with the increase in ageing workers in our society, fall-related injuries, especially 'fall on same level' injuries, need to be addressed.

Compensation cost of occupational falls on the same level

The National Safety Council reported that falls are the leading cause of death in the workplace and source of >20% of all disabling injuries (National Safety Council 2002). Although the overall frequency of non-fatal 'fall on same level' events

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decreased, the proportion of occupational 'falls on the same level' injuries increased from 12.8% in 2006 to 15.0% in 2009 (2.2% during these 5-year period). Moreover, same level falls have consistently ranked second among the top 10 causes of serious workplace injuries in the USA (Liberty Mutual WSI 2000–2010). In addition, the costs of fall-related accidents are high since debilitating fall injuries such as back injuries increase the number of DAFW (National Occupational Research Agenda 1996). In addition, several studies claimed that using worker compensation claims to estimate the cost of injury underreports the actual burden of the injury; injured workers may choose not to file a claim for a variety of reasons: unfamiliarity about the system, legal status, fear of losing job or mistrust from filing with supervisors or even fellow employees (Azaroff, Levenstein, and Wegman 2002; Boden and Ozonoff 2008; Boden, Biddle, and Spieler 2001; Eisenberg and McDonald 1988). Boden, Biddle, and Spieler (2001) suggested that the true economic burden of an injury to an employer includes the indirect costs of hiring and training replacements, the impact on the productivity of new workers and coworkers and the administrative and supervisory time devoted to an injury. Other indirect costs include loss of teamwork and communication, and reduced motivation for training (Koopmanschap et al. 1995; Van Beek, Van Roijen, and Mackenbach 1997; Berger et al. 2001).

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Limitation

Several limitations are noted. One of the main limitations is that the BLS data were subject to the employee's recollection of the incident and identification of the environmental risk factors. The narrative analysis method is limited by the completeness and consistency of the available text data (Lincoln et al. 2004). For instance, Lombardi et al. (2005) reported that it is not known whether words were truncated, forgotten, omitted or even lost in conversation by those reporting or recording the claim. There is growing evidence that the annual BLS SOII underestimates the true injury burden due to the underreporting of injuries (Azaroff, Levenstein, and Wegman 2002; Boden and Ozonoff 2008). A study by Leigh, Marcin, and Miller (2004) elaborated further, reporting that the Annual Survey missed from 33% to 69% of non-fatal injuries in 1999.

Another limitation is that the compensation costs taken from the Liberty Mutual (WSI) only reports the worker compensation cost for employees who missed 6 or more DAFW. Thus, we believe the actual number of falls and costs may be higher than what is reported in this study. Although the extrinsic factors, such as floor surfaces, are reported by the BLS, the intrinsic factors such as past history of falls, medication usage, physical and mental conditions (tiredness, diseases and fatigue), which often increase the risk of falls, were not noted. Lack of information on confounding factors such as body mass index is another limitation of this study, as obese adults fell almost twice as frequently (27%) as their lean counterparts (15%) per year (Fjeldstad et al. 2008), and are at a higher risk of fall (Matter et al. 2007; Wu, Lockhart, and Yeoh 2012). Moreover, this study was unable to determine the impact the organisation's safety culture may have had on fall injuries. Despite the limitations, the findings allow us to form a useful picture around the risk and cost of 'fall on same level' injuries and have helped to determine where more information is required.

Conclusion

This paper describes the non-fatal 'fall on same level' injuries in a large population of private industry workers in the USA. Overall, workers in the healthcare and social assistance industry, the transportation and warehousing industry, and the accommodation and food services industry had the highest risk for non-fatal workplace 'fall on same level' injuries. Apropos to gender and age groups, female workers had the highest risk of falls, while advancing age was congruent with a rise in incidence rates. Over 30% of 'fall on same level' injuries resulted in 31 or more workdays being lost. This study also indicated that $>70\%$ of injured workers had >1 year experience with the company when the accident occurred. The most affected body parts were the lower extremities and the trunk. Floor and ground surfaces were the major determinants in fall injuries, and 'fall on same level' accidents have been ranked second as a leading cause of injuries during the 4-year period being studied.

This information can be used to prioritise designing and implementing preventive measures in US private industry and to provide workers with the understanding of risk factors associated with falls in the workplace. Leamon and Murphy (1995) concluded that 'based on the frequency and costs to industry and workers, prevention of falls should be given a high priority.' Preventive actions by the employer should be multidimensional, including a review of organisational practices and policies, work environment, health management programming and options for employees to update professional competencies. As the workforce ages, we recommend that educating older workers to be more aware of their physical and cognitive limitations may be the first step towards alleviating the impact of age on the risk of 'fall on same level' injury. In addition, employers can play a critical role by monitoring working arrangements and facilitating appropriate adjustments in the physical work environment. Further investigations of gender, age and occupation-specific prevention measures may be beneficial for workers.

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