Injuries to Air Force Personnel Associated with Lifting, Handling, and Carrying Objects

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Background: The U.S. Air Force (USAF) active duty and civilian populations experience a substantial number of lost-workday injuries while lifting, handling, and carrying objects. Back injuries are most frequently reported.

Purpose: The purpose of this study is to describe the hazard scenarios of lift–handle–carry injuries to better identify effective countermeasures.

Methods: The data were derived from safety reports obtained from the USAF Ground Safety Automated System. Lift–handle–carry injuries for the years 1993–2002 that resulted in at least one lost workday were included in the study. A total of 4085 lost-workday injuries resulting in 24,940 lost workdays for USAF military and civilian members met the criteria for inclusion. Objects associated with these injuries were identified and aggregated to determine the most common causes of lift–handle–carry injuries.

Results: Twelve distinct objects or type of objects were identified as the most common source of lift–handle–carry injuries. Among the most common sources of injury were lifting aircraft components, boxes, and furniture. Most importantly, lifting one group of objects, aircraft components, was associated with 33% of all lift–handle–carry injuries.

Conclusions: Safety report data can be used to identify the most common object or object types causing lift–handle–carry injuries. The information included in this report suggests countermeasures that should be considered for implementation and evaluation studies. Countermeasures to address the most common lift–handle–carry injuries, such as lifting aircraft components among aircraft maintenance workers, are warranted.

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Introduction

Over the past decade, the Annual Survey of Occupational Injuries and Illnesses performed by the U.S. Department of Labor, Bureau of Labor Statistics (BLS) has consistently reported overexertion to be a leading cause of lost-workday injuries in private industry.[1] From 1993–2002, overexertion injury was also the leading cause of lost workdays among U.S. workers for 8 of the 10 years.[1] In the 2003 BLS survey specifically, overexertion accounted for 26% of all injuries and illnesses, with overexertion while lifting accounting for 55%, and overexertion while handling and carrying accounting for 13% of the overexertion injuries.[1] The BLS defines overexertion as an injury that results from excessive physical effort directed on an external source of injury. The physical effort may involve lifting, pulling, pushing, turning, wielding, holding, carrying, or throwing the source of injury. As a result, it is not surprising that material handlers and occupations with high physical workloads have been found to be at high risk for overexertion injuries.[2–4]

Numerous studies have attempted to identify the many factors involved in back pain to include physical, psychosocial, social, demographic, and occupational.[5–10] However, no studies of the lift–handle–carry injuries among military personnel, many of whom have very physically demanding jobs, have been conducted. The present study

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is part of a larger, descriptive epidemiologic study conducted by the U.S. Air Force (USAF) Safety Center to focus greater attention on, and reduce the number of, lost-workday injuries in the USAF. The purpose of the study was to identify objects and activities associated with lifting-, handling-, and carrying-induced injuries in an attempt to meet Department of Defense (DoD) injury reduction goals.

Methods

Detailed methods for developing and identifying hazard scenarios are given in a separate paper in this supplement to the *American Journal of Preventive Medicine*.[11] In short, lift–handle–carry injury data for the fiscal years (FY) 1993–2002 were obtained from the USAF ground mishap reporting system, the Ground Safety Automated System (GSAS). This study uses GSAS, a detailed USAF mishap reporting database to characterize lift–handle–carry injuries and identify the activities, objects, and occupational groups most often associated with these injuries. This report only includes injuries resulting in at least one lost workday. This injury category excludes injuries caused by slips, trips, and falls while lifting, handling, or carrying an object. The term lift–handle–carry is defined as an application of considerable directional force against an object in order to move it. GSAS data from 1993 through 2002 were analyzed and grouped by mechanism. The GSAS contains safety reports on military personnel (on- and off-duty) and on-duty DoD civilian personnel who experience a non-aviation, or ground-related, mishap. Civilian injuries are reported only if they occur on-base, or if occurring off-base when the employee is in a paid status. The injuries must also have caused 1 day or more of lost duty.

The initial step in this process was categorization of mechanism of the injury-producing mishaps by reading the one-line mishap description and/or full mishap report narrative as necessary. As a list of common objects had not previously been developed in GSAS, the list was formulated by aggregating similar objects and continually refining the list to capture the greatest number of objects under the fewest number of categories. As many objects were characterized using different levels of specificity, some degree of judgment was used during this process.

Frequencies are presented for lost-workday injuries, lost workdays, age, occupation and circumstances (object lifted/handled/carried, time of day), and injury outcomes (severity as measured by lost workdays, and injury type) related to lift–handle–carry injuries. Frequencies and crude injury rates are presented for military and civilian USAF personnel separately. For calculating military crude rates, person-year contribution was used for every airman. Age- and occupation-specific rates were not calculated as reliable denominator figures were not available. Given that approximately 80% of air force members are men, and unintentional injury rates in men are significantly higher than in women, the body of mishaps and injuries included in this report are predominately those of men.[11]

Table 1. Top ten external causes of lost workdays (ranked by total lost workdays), USAF civilian personnel, 1993–2002[a]

Rank	Activity	Total lost workdays	Total lost workday injuries	Lost workdays per injury (M/median)
1	Slips, trips, falls[b]	27,593	3251	8.5/4
2	Lift–handle–carry[c]	21,454	2854	7.5/4
3	Climb/descend stairs or ladders	10,469	1083	9.7/4
4	Struck or struck by object	6,090	998	6.1/3
5	Operating vehicles or equipment	2,217	190	11.7/5
6	Dropped object (hit by)	1,441	245	5.9/3
7	Handling	1,314	186	7.1/3
8	Riding in/on vehicles or equipment	1,056	100	10.6/4
9	Using hand tools	1,040	165	6.3/3
10	Using power equipment	683	88	7.8/4

[a]Total lost workday injuries and lost workdays were 10,563 and 83,392, respectively, for all activities/external causes (on-duty mishaps only).
[b]Includes various activities, but specific well-defined activities (e.g., playing basketball, softball, or climbing a ladder or stairs) were included in those more specific categories, not included in this general slips, trips, falls category.
[c]Not included in this category are injuries categorized as slips, trips, and falls that were associated with the acts of lifting, handling, or carrying.

Results

Among USAF military and on-duty civilian personnel, over the 10-year study period lifting, handling, and carrying activities generated 4085 lost-workday injuries, producing 24,940 lost workdays. Lift–handle–carry activities ranked third overall in both the number of lost-workday injuries and lost workdays. However, lift–handle–carry injuries were concentrated in the civilian workforce. When considering the civilian and military workforces sep-

arately, lift–handle–carry activities were the second leading cause of civilian injuries and total workdays lost (Table 1), with 2854 total lost-workday injuries (16 injuries per 10,000 worker-years) and 21,454 total lost workdays. For the military, with a total of 1231 lost-workday injuries (3.3 injuries per 10,000 worker-years) and 3386 lost workdays, lift–handle–carry events ranked fourth for injuries and tenth for total workdays lost (Table 2). On-duty military activities accounted for 724 lost-workday injuries (1.9 injuries per 10,000 worker-years). The lift–handle–carry injury frequency continually declined over the 10-year period with a 68% and 60% reduction in the civilian and military workforces, respectively, but the number of civilian injuries was still twice those of military personnel in FY 2002 (Figure 1). Examining on-duty injuries only, the frequency of lift–handle–carry injury reports declined 50% in the active duty population, but the frequency of reported lift–handle–carry injuries in the civilian workers was three times greater in FY 2002. The combined percentage of injuries occurring on-base was 90.8% (99% civilian and 72% military). In the active duty force, off-duty lift–handle–carry activities accounted for 502 or 41% of lift–handle–carry lost-workday injuries.

Reflecting the age distribution of the workforce, civilian injuries were primarily concentrated in those aged 35 years and older, whereas injuries in the military population were concentrated in those aged less than 35 years. The percentage of injury reports coded as back injuries declined with increasing age. The higher percentage of

Table 2. Top ten external causes of lost workdays (ranked by total lost workdays), USAF active-duty personnel, 1993–2002[a,b]

Rank	Activity	Total lost workdays	Total lost workday injuries	Lost workdays per injury (M/median)
1	Operating vehicles or equipment	46,818	4390	10.7/3
2	Slips, trips, falls[c]	14,554	2032	7.2/3
3	Riding in/on vehicles or equip	13,023	1147	11.4/4
4	Playing basketball	12,520	2165	5.8/2
5	Climb/descend stairs or ladders	6,902	965	7.2/3
6	Playing softball	6,843	1171	5.8/3
7	Trail riding—dirt bike/ATV/Quad	5,563	454	12.3/7
8	Playing flag football	5,406	939	5.8/3
9	Struck/struck by object	5,208	932	5.6/2
10	Lift–handle–carry[d]	3,386	1231	2.8/2

[a]Total lost workday injuries and lost workdays were 10,563 and 83,392, respectively, for all activities/external causes.
[b]Includes both on- and off-duty mishaps.
[c]Includes various activities, but specific well-defined activities (e.g., playing basketball, softball, or climbing a ladder or stairs) were included in those more specific categories, not included in this general slips, trips, falls category.
[d]Not included in this category are injuries categorized as slips, trips, and falls that were associated with the acts of lifting, handling, or carrying.
ATV, all-terrain vehicle

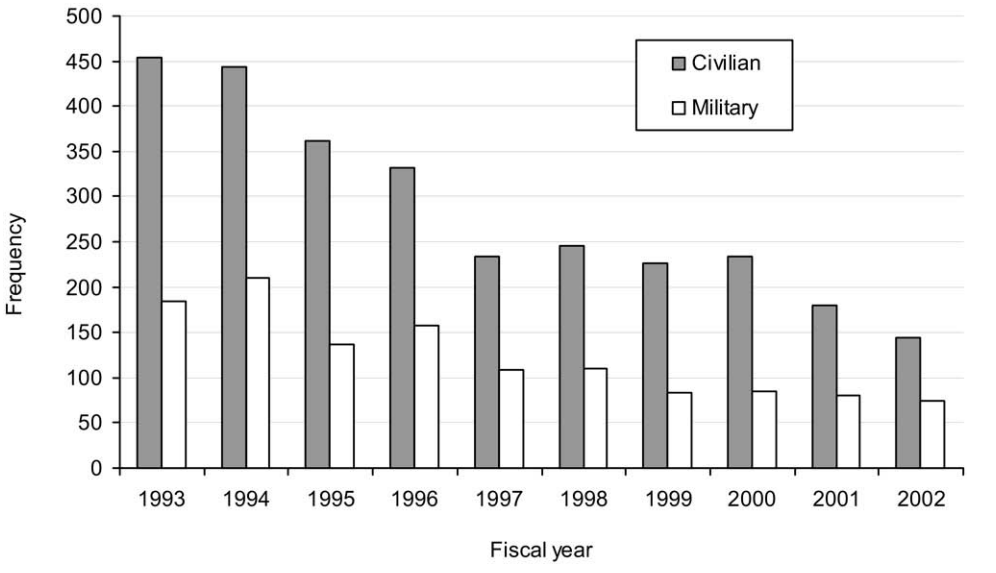

Figure 1. Frequency of lift–handle–carry injuries reported to AFSC by year and employment status, fiscal year 1993–2002

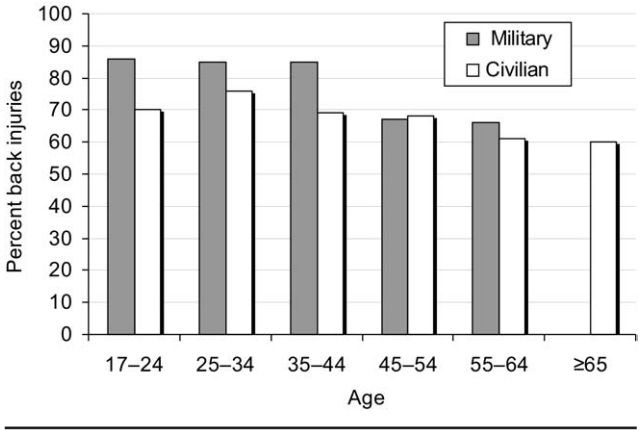

Figure 2. Percent of lift–handle–carry injuries reported to AFSC, coded as back injuries by age group (military versus civilian), fiscal year 1993–2002

back injuries in those aged less than 45 years was heavily influenced by the age distribution of the military population. The leading nature of injury in both the civilian and military populations was strains (87%). Of these strains, 74% were to the back; in the military workforce, 1037 (84%) injury reports involved a back injury, versus 1968 (69%) for civilians.

Although the civilian workforce had more than twice the number of lift–handle–carry injuries, a larger proportion of the younger active duty population's injuries were to the back (Figure 2). A large disparity between military and civilian workers also occurred in the severity of injuries, as measured by lost workdays. Lift–handle–carry injuries produced a mean of 7.5 and a median of 4.0 lost workdays per injury in the civilian workforce, while generating a mean of 2.8 and median of 2.0 lost workdays per injury in the military workforce. Analysis of time of day showed that lift–handle–carry injuries occurred mainly during the typical duty hours of 0700–1600 with a steady surge occurring through the morning hours, with the frequency peaking at 1000–1059 hours, just prior to the lunch hour, possibly suggesting that workers were tiring after several hours of exertion.

An examination of objects associated with on-duty lift–handle–carry injuries revealed objects, such as aircraft components, loaded boxes, and furniture to be the largest contributors to on-duty lift–handle–carry injuries (Table 3). Aircraft components were responsible for 1176, or 33% of all on-duty military and civilian lift–handle–carry injury reports. This was most evident in the active duty population where 54% of such injuries involved aircraft components.

When lift–handle–carry injuries were assessed by occupation (data not shown), it was found that these injuries affected mainly aircraft maintenance workers. Lift–handle–carry injuries represented 29% of all civilian aircraft maintainer injuries and 21% of military maintainer injuries. The overwhelming majority of maintainer injuries occurred to the back, with 81% and 65% of military and civilians, respectively, reporting back injuries.

Handling of furniture and boxes made a marked contribution to the overall frequency of lift–handle–carry injuries, generating 750 reports, or 18% of all military and civilian lift–handle–carry–associated injury reports (Table 3). The frequency of on-duty injury reports for civilians was more than four times that for active duty. In active duty personnel, handling furniture/boxes was the most common cause of off-duty lift–handle–carry injuries, accounting for 160 (32%) lost-workday injuries.

Discussion

For FYs 1993–2002, injuries sustained by lifting, handling, or carrying objects ranked third overall in the number of lost-workday injuries in USAF military and civilian personnel combined. Lift–handle–carry injuries were concentrated in the civilian workforce, ranking second only to injuries sustained while operating vehicles or equipment. Although lift–handle–carry injuries ranked fourth overall in producing lost-workday injuries in the active duty force, they were the leading cause of occupationally related injuries in the military workforce. The air force ranking of lift–handle–carry injuries is consistent with estimates reported by the U.S. Department of Labor for private industry employers, where exertion injuries have consistently ranked first in the number of lost-workday injuries.[1]

Although lift–handle–carry events were the second leading cause of civilian lost workdays, there was a 68% decline in these injuries from FY 1993 to FY 2002. The frequency of military lift–handle–carry injuries decreased by 60% between FYs 1993 and 1998, but the frequency remained unchanged from 1999 to 2002. The decline in the frequency of lift–handle–carry injuries was likely influenced by the personnel drawdown in the early 1990s. During the study period, the active duty force was reduced approximately 14%, whereas the civilian workforce was reduced 25%. Although the frequency of lift–handle–carry injury reports to the AFSC declined over the 10-year period, analysis of AFSC data indicate the crude active duty occupational injury rate trend remained flat; in contrast, the crude civilian occupational injury rate experienced a significant decline (unpublished data).

The greatest number of civilian lift–handle–carry injuries was reported in workers aged 35 or older, whereas the military workforce had the fewest number of injury reports in this age category. This distribution can be attributed to the overall age distribution of the civilian

workforce, where most are in the category aged >35 years. The low number of military injuries in this age category is likely reflective of the movement of career airmen away from the industrial functions into administrative functions as they progress through the ranks.

The number of lost workdays per injury was greatest in the civilian workforce, where the median number of lost days was 4.0, versus 2.0 in the active duty force. The older age distribution in the civilian workforce may account for the increased number of lost workdays as the older worker may require a longer recovery time. Although there appears to be a disparity in the severity of injury between the civilian and military workforces, USAF workers (both military and civilian) lost fewer workdays per injury than private sector workers. BLS survey data over the same time period reveals that the median number of lost work days for overexertion due to lifting or carrying ranged from 6–9 days. The predominate injury in both the USAF and private industry workforces was strains, with the overwhelming majority occurring to the back.

Table 3. Common objects associated with on-duty lifting, handling, carrying injuries, USAF military and civilian personnel, 1993–2002

Active duty members[a]		
Object	**Example**	**Lost workday injuries (% of total)**
Aircraft components	Lifting aircraft tail	393 (54)
	Excludes: removing engines	
Boxes (loaded)	Lifting boxes of meals ready to eat	60 (8)
	Excludes: lifting boxes of files	
Furniture (office)	Moving office desk	51 (7)
	Excludes: moving computer equipment	
Bag/sack (loaded)	Loading/carrying sandbags	32 (4)
	Excludes: filling sandbags	
Toolbox	Lifting toolbox	30 (4)
	Excludes: pushing loaded tool cart	
Civilian employee[b]		
Aircraft components	Lifting electronic countermeasure pod	783 (27)
	Excludes: engines	
Boxes (loaded)	Lifting boxes of auto parts	286 (10)
	Excludes: boxes of paper files	
Furniture (office)	Moving computer desk	193 (7)
	Excludes: moving computer equipment	
Child	Lifting from crib	110 (4)
	Positioning baby	
	Excludes: pushing baby in stroller	
Stand	Moving maintenance stand	92 (3)
Cart/dolly	Pulling battery cart	81 (3)
Door/hatch	Pushing hanger door	74 (3)
Engines/transmissions gearboxes	Pulling engine	68 (2)
	Lifting pump motor onto truck	
	Excludes: pushing engine stand with engine on it	
Boxes of paper	Carrying printer paper Lifting files	57 (2)
Computer equipment	Lift/carry personal computer to cubicle	51 (2)

[a]Table limited to activities causing three or more lost-duty-day injuries per year (total: 724 lost workday injuries).
[b]Table limited to activities causing five or more lost-duty-day injuries per year (total: 2849 lost workday injuries).

Back injuries are a leading cause of lost workdays, workers' compensation claims, and disability in the U.S.[12] In 1996 low back pain accounted for nearly 15% of all claims and nearly 55% of indemnity costs.[5] In 1999 the estimated rate of workers' compensation claims for back injury was 58 per 10,000 workers covered.[6] Occupations with high physical workloads have been shown to be associated with increased reports of back pain and other musculoskeletal injuries. Many of the higher risk occupa-

tional activities involve lifting, carrying, and handling. Numerous studies have attempted to identify the factors most likely to be associated with back pain to include physical, psychosocial, social, demographic, and occupational.[5–10] One study estimated that 37% of low back pain worldwide is due to occupational factors.[13] An analysis from the 1990 Ontario Health Survey estimated 25% of back pain to be related to physical occupational workloads.[14] Data from the U.S. National Health Interview Survey revealed the prevalence of work-related lost-workday back pain was 4.6%, resulting in over 101 million lost workdays.[15]

Back injuries were highly associated with USAF lift–handle–carry injuries; overall, 74% of such injuries involved the back. This analysis revealed a smaller percentage of lift–handle–carry injuries involving the back among older workers; however, the percentage of back injuries in the oldest age group was still 60%. Other studies have indicated that younger workers, and those with less experience on the job, were more susceptible to low back injury.[2–4]

In 2003, the BLS survey identified the back as the body part most affected (184,850 injuries, 60%) by overexertion events.[1] The most common source of overexertion injury was handling containers. Material handlers have been found to be at high risk for overexertion back injuries. One study of material handlers in a home improvement retail business reported a rate of 4.25 per 100 full-time worker equivalents for low back injuries, and these rates were similar across age groups, even when considering length of employment and lifting intensity.[2] Another study of home improvement store workers found injury rates to be highest among employees both aged <25 years and time on the job of less than 2 years, and those with the greatest lifting and handling requirements.[3] Another study of retail merchandise material handlers reported injury rates similar to the previous study in those workers with the greatest physical work requirements, but the rate for those with lesser requirements was 50% of that of workers with the greater physical requirements.

Ostbye et al.[16] found that body mass index had a strong effect on occupational injury claims and lost work days, and this effect was strongest in occupations most associated with lifting. Similarly, Pollack et al. [17] found that traumatic workplace injuries increased with increasing body mass index, and this association was greatest for acute sprains/strains. These findings could further explain the apparent difference in injury reporting for lift–handle–carry events between civilian and military workers. Military workers are generally younger, with most being removed from industrial functions before the age of 40, and are less likely to have excess body mass as they must maintain a prescribed level of fitness. Although the active duty force suffers fewer overall reportable injuries with fewer lost days per injury, it is of interest that the overwhelming majority of injuries from lift–handle–carry events were to the back.

Objects

Aircraft components were the leading cause of on-duty lift–handle–carry injuries in both military and civilian workforces. However, aircraft components affected a greater proportion of military personnel (54%). In contrast, loaded boxes and furniture affected equal proportions of both military and civilian workers. Given the impact aircraft components had on lift–handle–carry injuries, aircraft maintenance functions were ranked first in producing both the number of lost workday injuries and lost workdays for both civilian and on-duty military injuries. Lift–handle–carry injuries represented 29% and 21% of the total injuries to civilian and military aircraft maintenance workers, respectively.

However, this discrepancy is probably influenced by the fact that military maintainers spend less time over their careers performing the industrial functions of the job. As military members progress in rank they are moved into supervisory positions or assigned other collateral duties, whereas civilian counterparts may perform the "hands-on" industrial functions throughout their career. Furthermore, the civilian employee is entitled to workers' compensation benefits and thus is provided an added incentive to report occupational injuries, which could potentially influence reporting frequency among civilian workers.

Off-duty activities accounted for 502 lost-workday injuries in the active duty population. However, this figure is likely to be greatly underestimated as it is dependent on the victim notifying their supervisor as to the cause of their injury and the supervisor initiating a mishap report, which in turn is investigated by safety personnel. Handling furniture and loaded boxes were the two most frequent off-duty, lift–handle–carry, injury–generating activities. This finding has significance in that active duty military can be expected to make numerous household moves during a career, providing greater opportunity for exposure and resulting injury. Even though moving contractors are hired to move household goods, active duty members can be expected to at least move furniture and boxes between rooms when resettling. The combined exposure of both on- and off-duty handling of furniture and boxes made a contribution to lift–handle–carry injuries second only to aircraft components, which affects primarily aircraft maintenance technicians. Handling of furniture/boxes affects a much broader population in a greater variety of settings, making targeted interventions more difficult.

Prevalence estimates have revealed that unstructured workplaces (workplaces where multiple tasks are per-

formed) such as construction work, nursing homes and building supply retailers tend to have the highest occupational risks.[10,18,19] Many USAF workplaces are unstructured, and workers perform a variety of tasks, making prevention more challenging. The highest risk functional area was found to be aircraft maintenance workers handling aircraft components. To achieve a significant reduction in lift–handle–carry lost-workday injuries, more preventive measures should be focused on the aircraft maintenance functional area. Aggressive preventive measures should be implemented and existing policies enforced.

Preventive Measures

Preventive measures should include use of mechanical lifts and comprehensive training on their use; manual lifting techniques; and assessment of procedures and lifting requirements of various maintenance tasks. Collins et al. conducted an intervention trial of a lift–handle–carry injury-prevention program implemented in six nursing homes to assess the reduction of musculoskeletal injuries in a high-risk group.[20] The implementation of mechanical lifts, a written "zero lift" policy, and improved training substantially reduced injury rates caused by resident handling for first-time injury reports, workers' compensation claims, and reportable injuries on Occupational Safety and Health Administration reporting logs, regardless of age or job experience at all sites studied. To achieve further reductions in overexertion injuries, the USAF should adopt similar approaches to controlling lift–handle–carry injuries, and implementation of countermeasures should be evaluated for effectiveness. Ergonomic guidelines are available to assist workplace supervisors in instituting safer methods and policies for material handling.[21] Efforts to reduce off-duty lift–handle–carry injuries would appear to be more challenging, but more education in proper lifting techniques, and perhaps moving equipment (e.g., a dolly), could be made available to those transitioning or planning to move bulky objects. Back injuries are multifaceted, caused by a combination of physical workload, psychosocial, social, demographic, and occupational factors. Prevention strategies should take into consideration multiple factors where possible.[10] USAF employees may have a higher potential for exposure due to a greater variety of work tasks and locations. Broader prevention efforts should incorporate efforts in promoting greater job control and health promotion in the civilian workforce.[10]

Conclusion

By categorizing major causes of injury, this study demonstrated not only that lift–handle–carry injuries are a hazard to USAF military and civilian personnel, but it also demonstrated the potential value of safety data for workplace epidemiology. AFSC data show that in terms of raw numbers, lift–handle–carry injuries should be a priority for prevention. These safety data provide clues about what activities are most hazardous. Epidemiologic studies using safety data should be conducted to identify USAF populations at greatest risk and to identify modifiable risk factors for lift–handle–carry and other injuries. This study is the first step in making better use of USAF safety data for prevention of lift–handle–carry and other injuries.

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