Using Safety Data to Describe Common Injury-Producing Events
Examples from the U.S. Air Force

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Background: The U.S. military leadership has recently increased its efforts to reduce the number of lost-workday injuries for both the active duty and civilian employee components of the total force. The detailed causes and circumstances of those nonfatal injuries—information needed for injury prevention— has largely been unexplored. The purpose of this project was to determine the utility of Air Force safety data for nonfatal injury prevention.

Methods: In 2004, events associated with injury-producing mishaps reported through the U.S. Air Force (USAF) Ground Safety Automated System from 1993–2002 (n = 32,812 injuries) were reconstructed. Essential data elements necessary to reconstruct event causes and circumstances were identified in both coded data and in free-text mishap narratives. Activities and mechanisms were coded in a format similar to that of the ICD-10. A taxonomy was then developed to identify hazard scenarios associated with injury-producing activities or mechanisms.

Results: Coded data provided only four data elements (activity, injury event/exposure, nature of injury/body part, and outcome) that were sufficiently descriptive for prevention purposes. Therefore, narrative information was coded and analyzed to obtain additional information. The assembled data enabled identification and description of hazard scenarios associated with the most common injury-producing activities and mechanisms.

Conclusions: Safety reports from the USAF provide detailed mishap descriptions for lost-workday injuries that could support in-depth analysis and more effective preventive efforts. However, some of the most valuable information is found in the pre-text narratives that require coding and classification, such as was conducted for this report in order to be optimally useful for injury epidemiology and prevention.
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Introduction

It is well established that injuries are the leading cause of morbidity and mortality among military service members.[1,2] U.S. military leaders have historically utilized safety data on the causes and circumstances of unintentional injuries at the highest levels of severity, particularly fatalities, to establish successful injury prevention programs. Examples of such successful military fatality prevention programs include motor vehicle and aviation safety.[2] Fortunately, the frequency of these and other fatal mishaps is low in both absolute terms and relative to the more frequent and less severe mishaps/injuries near the base of the injury pyramid. The biggest impact on readiness and health of service members results from nonfatal injuries.[1,2] Safety investigations of the less severe mishaps such as those producing only lost duty time (i.e., nonfatal and nondisabling, safety Class C) are not as rigorous or detailed as investigations of those mishaps that produce injuries of greater severity (Class A, deaths and B, disabilities). This information limitation, along with the large number of possible injury-producing scenarios, has resulted in an incomplete understanding of the causes and circumstances behind these less severe,

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nonfatal injuries. This is problematic because from a total injury burden perspective, the lost-workday injuries, which are mostly Class C, represent the majority, approximately 96%, of the injury burden reported to the Air Force Safety Center (B.R.B., 2008, unpublished data).

As a result of the growing knowledge that nonfatal injuries have an enormous effect on the health and performance of service members, in 2003, the Secretary of Defense directed the military service branches to reduce their lost-workday mishaps by 50% within 2 years.[1] To achieve material reductions in the overall injury burden as the directive mandated, it became obvious early on that an exclusive focus on the Class A/B injuries (deaths/disabilities) would fail to achieve the overall goal for reductions. Prevention of the more frequently occurring nonfatal, unintentional injuries requires an understanding of the events that produce them. Thus, the purpose of this endeavor was to systematically code and assess the large volume of Air Force, nonfatal, lost workday–mishap data to determine their potential value for injury prevention. The results of the project were reported to the Defense Safety Oversight Council's Military Training Task Force in 2004.

Methods

This study was conducted in two phases. The first phase, coding and classification, was completed in May 2003, and the second phase, aggregation into meaningful hazard scenarios and descriptive analysis, was completed in November 2003. This paper provides the methods for both efforts, but the results section of this paper will reflect mostly the findings from the Phase-1 process. Selected Phase-2 results, the hazard scenarios analysis, will be shown in the companion papers within this supplement.[4–7] The goal of this endeavor was to develop hazard scenarios that define the victim, the source of injury, the environment, and the activity. Hazard scenarios can be developed for different events and used as organizing principles. According to Drury and Brill,[8] to be useful, (1) a maximum of six scenarios should account for more than 90% of the mishap events; (2) for each scenario at least one apparently feasible and effective intervention could be applied; (3) each scenario is mutually exclusive of others; and (4) each scenario has human factors as a major parameter.

Population and Injury Outcomes

The population in which the mishaps examined by this report occurred was the active duty U.S. Air Force (USAF). Over the 10 years examined (1993–2002) the population of the air force decreased from 442,024 in 1993 to 360,197 in 2002. Over that period, 32,812 mishaps were reported to the Air Force Safety Center by safety officials and commanders throughout the USAF. These mishap reports included deaths, disabilities, and lost-workday injuries. The focus of this report is on the nonfatal lost-workday injuries, which were also the focus of the Defense Safety Oversight Council (DSOC).

Inclusion and Exclusion Criteria

Mishap report information was extracted from the USAF Ground Safety Automated System (GSAS) for Fiscal Years (FY) 1993–2002, from both coded data elements and narrative text information. GSAS is a web-enabled application used by the more than 300 safety offices throughout the USAF to report mishaps to the Air Force Safety Center. As such, this system may be considered as an event and injury surveillance system serving the Air Force community, which is composed largely of young, male, enlisted personnel (Table 1). As with other contemporary military populations, the Air Force differs markedly from civilian populations, which have a greater proportion of women and are older (and thus less physically active as a rule). GSAS also functions as an occupational injury surveillance system for civilian employees, a somewhat older population (data not shown).

Mishaps in this safety database met Department of Defense (DoD) reporting requirements at the time of the event, the primary one being that the injuries sustained in the mishaps are unintentional. Reporting rules are contained in DoD Instruction 6055.7, which can be viewed in its entirety at www.dtic.mil/whs/directives/corres/pdf/605507p.pdf. In short, the reporting threshold for each class of injury-producing mishaps is as follows:

1. Class A—fatality, or permanent total disability
2. Class B—permanent partial disability
3. Class C—injury causing loss of 1 or more days away from work beyond the day or shift it occurred, or injury causing a permanent change of job.

Because of the DSOC interest in preventing lost-workday injuries, this report focuses on Class C mishaps. Although GSAS allows data retrieval of mishaps back to 1971, the current project analyzed data from 32,812 reports from the 10-year period 1993–2002.

Flight safety mishap data were excluded from this study because the existing coding of these electronic reports did not clarify which person or people, among several individuals associated with a multi-person mishap, sustained the

Table 1. Demographic profile, U.S. Air Force active duty for the midpoint of the 1993–2002 study period

Age (years)	Personnel	% of all personnel	Male (%)	Enlisted (%)
17–24	108,982	30	75	95
25–34	141,614	39	83	77
35–44	100,926	28	87	75
≥45	11,673	3	85	30

lost-workday injury. It is estimated that the exclusion of flight mishap data undercounted lost-workday injuries by 1%–2% at most.

The analysis also excluded fatal (Class A) injuries in which death was immediate or when a person was medically retired shortly after an injury, leading to a prognosis of imminent death or certain permanent disability. In these rare situations, the total accumulation of lost workdays would have been zero, or the mishap not reported at all given that the victim was no longer on active duty when death occurred. Those injuries in which duty days were lost before the person died were included in this analysis (n=10). This selection criteria resulted in a data set that was overwhelmingly classified as Mishap Class C, not the immediately fatal (Class A) or disabling (either Class A or Class B) mishaps. The data collection did not include intentional injuries (suicides, homicides, or injuries sustained in combat) as separate systems exist for those incidents.

Military personnel assigned to the AF Reserves Command (AFRC) or Air National Guard (ANG) were also excluded from the analysis as their narrative reports were less detailed and would have generated considerable missing data for the scenario reconstructions. This categoric exclusion assumed that all such unit assignments were valid indicators of the component (i.e., active duty, ANG, AFRC) that the person actually belonged to. As an example, an airman assigned to an AFRC or ANG unit was assumed not to be an active duty component troop merely assigned to that unit, or vice versa. This assumption did not hold in all cases, but nonconforming situations were the exception, not the rule. No other reliable method existed to precisely differentiate between an individual's "owning" component (e.g., active duty, AFRC) and his/her unit's command of assignment. For instance, an airman reservist could be working within an active duty command for varying durations. Administratively, while the reservist airman belongs to the AFRC, (s)he is "loaned out" to that active duty unit.

The following extraneous categories of personnel were systematically excluded from this study: cadets, foreign nationals, Youth Opportunity Program workers, non–U.S. military, non–Air Force military, and contractors. Injuries occurring within those groups would either be nonreportable according to federal law or a group for which the Air Force is not officially accountable. Mishaps and injuries occurring during basic military training were recorded in another data system not linked to the safety reporting system for the operational Air Force, thus those injuries were not included in this analysis. The study did, however, include both Department of the Air Force civilian employees and military paid from nonappropriated funds.

For active duty military personnel, both on- and off-duty mishaps and injuries were included in the database. Off-duty civilian employee mishaps are not reportable, thus those injuries are not in the GSAS database. As such, the field of reported injuries for civilian employees is generally of occupational etiology in the broadest sense. However, data presented in this paper did not necessarily reflect official classification and reporting of occupational injuries. Many Air Force civilian injuries in the database were incidental to paid work duties specific to occupations. As an example, there were numerous slips and falls in the parking lot or on sidewalks going to and from the various workstations. A breakout for occupation-unique "industrial injuries" is not presented here. Thus, data on civilians shown here were a combination of incidental and industrial as all were officially reported to GSAS as occupational.

Mishap Classification, Coding, and Event Reconstruction

In preparation for the intricate event reconstruction, already-coded broad data elements from the safety database (category, subcategory, and activity) were primarily used to group mishaps along the lines of the ICD-10[9] classification system. Examples of categories as defined in GSAS are Motor Vehicle, Sports and Recreation, and Ground Industrial. Not all categories have subcategories (e.g., Sports and Recreation), but a subcategory of Motor Vehicle is Privately Owned Vehicle. Once grouped into those ICD-like categories (e.g., falls from one level to another), a taxonomy unique to each of those categories was developed, with descriptive hazard scenarios and potential interventions or solutions accompanying each. Examples of such scenarios for slips, trips, or falls include the following: slipped and fell on snow/ice exiting (or entering) vehicle in the parking lot; slipped and fell on wet surface in food preparation area; fell from stepping into animal hole on-base while running, not in a formation; or, fell from [specified type of aircraft] wing during refueling. Since the ICD-10[9] system is ill-suited for describing injuries occurring within sports and recreation mishaps, more detailed lists of activity-specific hazard scenarios were created. This was also done for other activities or mechanisms where ICD-10[9] lacked the codes required for describing injuries in the military.

A three-step scenario-development process was employed. The process consisted of the following: (1) rendering each mishap narrative and developing unifying standard descriptive phrases (hazard scenarios), (2) tabulating and identifying the most common scenarios, and (3) adjusting scenarios to be more inclusive or exclusive depending on the appropriateness of classification. The goal of this iterative process was to minimize the number of unique scenarios by finding their commonality in three to four different aspects/elements while preserving enough detail to deliver relevant and useful prevention information. The operational premise was that although every mishap is unique, events with similar characteristics could be meaningfully aggregated.[10] Lack of such aggregation would have resulted in numerous scenarios so unique that an intervention targeted at any one scenario would have prevented too few injuries to substantially reduce the overall injury burden.

To quantify the impact of injuries on readiness, numbers of injuries, duty days lost, and days lost per injury were totaled to rank them within each category (either an activity or a mechanism). Military and civilian employee injuries were assessed both individually and in combination. Both the mean and the median number of days lost per injury were calculated in every category since the frequency distribution of several categories of injuries was severely right-skewed due to a few mishap events with extremely high values for days lost.

To expand the analysis of certain injury mechanisms, coded database elements were used such as age, rank, civilian/military status, number of lost duty days, injury class, body part injured, nature of injury (e.g., fracture or sprain/strain), functional duty area, and other descriptors. The injured body part coding was recoded without reference to "sidedness" (left or right) of an injured limb, appendage, eye, or ear. While a person's gender is available from GSAS, the study team elected not to analyze men and women separately. Such an analysis was beyond the goals of this exploratory analysis of nonfatal mishaps reported to the Air Force Safety Center. Also, given that about 80% of the Air Force population is men, the bulk of mishaps and injuries included in this series affected predominantly men.

The most common hazard scenarios were placed into tables by their frequency ranking within categories of activities and were then separated into military and civilian employee categories. The tables were not exhaustive, as space and time limitations prevented us from showing all but the major generators of injuries.

The top generators of lost-workday injuries categorized by both activity and injury mechanism (external cause) were identified. The data presented are limited to activities or mechanisms that produced at least 3000 total lost duty days. Falls from stairs and ladders in the slips, trips, and falls category were included within the activity tables, but the subcategory of falls is also shown separately within the mechanism data tables. As such, the slips, trips, and falls shown in the activity tables are the only exceptions to the mutually exclusive categorization and presentation scheme. Climbing stairs and ladders was specifically broken out as an activity because of the widespread reliance on ladders and ladder-like appliances in USAF activities, in not only generic tasks (e.g., physical plant maintenance) but also aircraft-related functions. Examples of functions that could involve climbing ladders or stairs include aircraft maintenance and repair, inspection, cleaning, painting, weapons (off)loading, configuration of cargo compartments, flight crew and passenger (de)boarding, and refueling. Hazard scenarios for selected injury-related activities and injury mechanisms presented in this report are described in detail in separate articles in this supplement to the *American Journal of Preventive Medicine*.[4–7] Three sports (basketball, softball, and football) and lifting, handling, and carrying injuries will be examined in subsequent articles in this supplement.

The percentage of activity- or mechanism-specific injuries resulting in fractures was used as another marker for injury severity in addition to lost workdays. While injuries of greater severity than fractures were reported, their numbers were small. Fractures were more easily and consistently classified by safety officials who report mishaps to GSAS, and they produced higher numbers of lost duty days per injury than most other types of injury, such as sprains or strains.

Results

Military and civilian Air Force members incurred 32,812 lost-workday injuries during the 10-year period of this investigation. A total of 22,249 injuries were reported on USAF military personnel, accounting for 171,202 lost duty days. The lost duty day total for this group accounted for 67% of the total force (military and civilian employee) burden of 254,507 lost workdays. Civilian employees lost a total of 83,392 workdays from 10,563 injuries. If off-duty injuries ($n=18{,}375$) are subtracted from the military total, that group's lost duty time dropped to 24,861 duty days compared to the civilian employee total of 83,392 lost workdays (data not shown). Thus much of the difference in numbers of injuries and lost workdays for active duty military personnel was due to off-duty and recreational activities not captured in civilian employee data.

Military Descriptive Analysis

For active duty military personnel, operating equipment and driving vehicles (personal, rented, or government-maintained) resulted in lost workdays and total lost-workday injuries that were more than three times as frequent as the second-ranked activity, riding in or on vehicles or equipment (i.e., passengers/riders, not operators; Table 2). Injuries sustained while participating in sports and recreational activities accounted for most of the remaining injuries. The percentage of reported injuries that resulted in fractures ranged from 24% for basketball injuries to 60% for dirt biking/all-terrain vehicle (ATV) use. The fifth-ranked activity for producing lost-workday injuries was climbing or descending stairs or ladders. Injuries sustained while operating vehicles/equipment, or riding in or on them, usually (93%) occurred in off-base mishaps involving personally owned motor vehicles (data not shown). Injuries for sports/recreational activities usually occurred on the military installation, except for trail riding/dirt biking, which were over 80% off-base.

With the exception of sport vehicle riding, sports and recreation injuries are more notable for their frequency than the number of lost workdays per injury (Table 2). In

Table 2. Predominant activities and injury mechanisms generating lost duty days in USAF active duty personnel

Ranking	Activity or mechanism	Total lost workdays	Total injuries reported	Lost workdays per injury (M/median)	Fractures (%)	On-base (%)
Activity						
1	Operating vehicles or equipment	46,818	4,390	10.7/3	31	13
2	Riding in or on vehicles or equipment	13,023	1,147	11.4/4	33	16
3	Playing basketball	12,520	2,165	5.8/2	24	78
4	Climb/descend stairs or ladder	6,902	965	7.2/3	44	59
5	Playing softball	6,843	1,171	5.8/3	44	71
6	Trail riding—dirt bike/all-terrain vehicle	5,563	454	12.3/7	60	8
7	Playing flag football	5,406	939	5.8/3	36	74
Mechanism						
1	Slips, trips, and falls[a]	20,646	2,997	7.2/3	31	60
2	Struck object/struck by object	5,208	932	5.6/2	22	73
3	Lifting/carrying object[b]	3,386	1,231	2.8/2	3	72

[a]Excludes sports and recreation falls. Major activity breakdown: climbing or descending stairs and ladders (see Table 1); walking (n=2363); stepping up or down to/from uneven surfaces (n=380); entering/exiting buildings or vehicles (n=368); carrying items (n=254); handling or carrying items/equipment (n=155); running not associated with jogging, sports, or training (n=138).
[b]Does not include injuries resulting from being struck by objects that the person had dropped, or pedestrians injured by motor vehicles while carrying an object.
USAF, U.S. Air Force

general, sports activities had fewer extreme values for the number of days lost, resulting in fewer lost workdays per injury than injuries from other activities. However, dirt biking and riding ATVs generated the most lost workdays, a median of 7 lost days per injury and an even higher mean value of 12.3 days per injury.

The leading lost-workday injury mechanism causing the most lost workdays was slips, trips, and falls, with over 20,000 total lost workdays stemming from nearly 3000 injuries (Table 2). Nearly one third of these reported mishaps resulted in a fracture, and most (60%) occurred on-base. Being struck by an object or vehicle, or striking an object or vehicle was the second most frequent injury mechanism (73% occurring on-base), but with only about one fourth the number of lost-workday injuries as for slips, trips, and falls. Lifting or carrying an object or person was the remaining major contributor with 3386 total lost-workday injuries (72% occurring on-base), but the mean and median numbers of lost days per injury were both low and relatively equal, indicating that few of these injuries resulted in large numbers of lost workdays. Only 3% of injuries from this mechanism were fractures (most were sprains/strains, data not shown). While 60% of slips, trips, and falls occurred on-base, the other two major mechanisms were even more likely to have occurred on-base.

Injured airmen were most likely to have been assigned to aircraft maintenance functional/work areas, accounting for 6% of all lost-workday injuries (Table 3). However, those 1289 lost-workday injuries paled in comparison to the off-duty category where over 18,000 injuries occurred, 82% of the lost-workday injury total.

Table 3. Predominant functional areas or domains generating LDI unintentional injuries in USAF active duty personnel, 1993–2002

Rank by total injuries	Functional duty area	Number of lost workday injuries	Reported injuries (%)
1	Military off-duty	18,250	82
2	Aircraft maintenance	1,289	6
3	Civil engineering	546	2
4	Security	365	2
5	Combat training	222	1
6	Operations	207	1
7	Communications/ computer operations	186	1
8	Supply/logistics	185	1
9	Transportation	170	1
10	Medical/health services	137	1

Totals do not add up to 100%, as 4% fell into several smaller areas.
LDI, lost duty day; USAF, U.S. Air Force

Interpretation of Table 3 data is complicated as an assigned functional work area may not indicate the environment in which a mishap occurred. For instance, a medical care provider sustaining an injury while operating or riding in an ambulance would have contributed to the medical/health services functional area, not transportation.

Civilian Employee Descriptive Analysis

"Climbing, working from, or descending stairs or ladders" was the work activity that produced the most lost-workday injuries among civilian employees (Table 4). This activity was a subset of the slips/trips/falls injury mechanism that produced over 38,000 lost workdays from over 4000 lost-workday injuries. Operating vehicles or equipment was the second-ranked civilian activity, but it produced only about one fifth of the total lost workdays and injuries as stairs/ladders. Both the mean and median lost days per injury for operating vehicles and equipment were, however, higher than all other activities, even though only 14% of the injuries in this category were fractures. A secondary analysis, not shown, found that most (56%) of the civilian-operator vehicle/equipment injuries were incurred while operating special-purpose vehicles or motorized equipment such as aircraft tugs and forklifts. This contrasts with the military-operator vehicle/equipment injuries in which 93% occurred while operating motor vehicles, usually personally owned. The civilian-operator vehicle/equipment injuries were not exclusively on-base incidents, as 27% of those occurred off the military installation, generally hauling cargo or operational crews (e.g., missile launch control officers). The remainder of the civilian activities, handling or manipulating objects, using hand tools, and using power equipment were, with the exception of riding in/on vehicles and equipment, unlike the predominant active duty military activities. It is also notable that the proportion of civilian injuries producing fractures was significantly lower than military activities of similar ranking.

Almost all of the top civilian injury-producing mechanisms occurred on-base (Table 4). Slips/trips/falls and lifting or carrying objects (or people in some circumstances) were the top two injury generators. Severity overall was not particularly great, as evidenced by the low to moderate proportion of injuries that were fractures. However, those top two categories each generated an additional lost workday per injury (measured by median days lost) compared to the last two categories. Almost three of four civilian injuries occurred to individuals working in three areas: Aircraft Maintenance, Services/Morale Welfare and Recreation, and Civil Engineering.

Table 4. Predominant activities and injury mechanisms generating lost workdays for USAF civilian personnel, 1993–2002

Ranking	Activity or mechanism	Total lost workdays	Total injuries reported	Lost workdays per injury (M/median)	Fractures (%)	On-base (%)
Activity						
1	Climbing/descending stairs or ladders	10,469	1083	9.7/4	20	99
2	Operating vehicles or equipment	2,217	190	11.7/5	14	73
3	Handling/manipulating objects, general	1,314	186	7.1/3	<1	99
4	Riding in/on vehicles or equipment	1,056	100	10.6/4	24	78
5	Using hand tools	1,040	165	6.3/3	<1	100
6	Using power equipment	683	88	7.8/4	<1	100
Mechanism						
1	Slips, trips, and falls[a]	38,062	4334	8.9/4	19	98
2	Lifting/carrying object[b]	21,454	2854	7.5/4	<1	99
3	Struck object/struck by object	6,090	998	6.1/3	16	99
4	Dropped object (hit by)	1,441	245	5.9/3	23	99

[a]Major activity breakdown: climbing or descending stairs and ladders (10,469); walking (n=1619); entering/exiting buildings or vehicles (n=263); stepping up or down to/from uneven surfaces (n=238); carrying items (n=170); handling or carrying items/equipment (n=88); sitting on a chair or stool (n=87).

[b]Does not include injuries resulting from being struck by objects that the person had dropped, or pedestrians injured by motor vehicles while carrying an object.

USAF, U.S. Air Force

Discussion

This explorative, descriptive project illustrates the potential value of safety data for an important category of injuries, those resulting in 1 or more days of lost duty. The endeavor shows that data from the Air Force Ground Safety Automated System can be coded and aggregated into a few meaningful categories of injury-generating activities and mechanisms, such as operating vehicles, climbing stairs, and playing basketball; or slipping, tripping, falling, and lifting or carrying an object, respectively. These categories can be used to identify priority problems or to focus prevention initiatives. Categories of activities identified in this paper can be further refined into hazard scenarios in the manner described in this paper. In a series of companion papers, hazard scenarios are described in detail for basketball, softball, flag football, and lifting and carrying.[4–7] Examples of hazard scenarios for basketball include such situations as "jumped and landed on player's foot," "collisions," and "ran and pivoted or cut." For softball-specific injury, hazard scenarios include such events as sliding into a base, being hit by a ball, and collisions with other players. For lifting and carrying, mishap-hazard scenarios included most categories of objects such as "aircraft components," "boxes," or "furniture."

Our methods for coding, classifying, and reconstructing mishaps, and developing hazard scenarios closely resembled those methods developed and described elsewhere.[11] That work was published about 1 year after the current work was concluded. It used U.S. Army safety data to develop event reconstruction syntax and taxonomy drawn from both coded and narrative data from the army's reporting system, which operates under the same DoD guidelines as that of the Air Force. The goal for event reconstruction was, like Lincoln's, to find hazard scenarios responsible for relatively large numbers of mishaps, each potentially preventable using the same scenario-specific interventions. While the current parallel system was not developed as fully as that of Lincoln et al.,[11] the basic framework correlated well with his model.

The nine types of data elements recommended for event reconstruction by Lincoln et al.[11] consisted of: (1) broad activity (e.g., maintenance work), (2) task (inspecting engine), (3) contributing factor (e.g., greasy hands), (4) precipitating mechanism (e.g., slip), (5) injury event/exposure (e.g., fall from elevation), (6) primary source (e.g., hard surface), (7) secondary source (e.g., vehicle bumper), (8) nature of injury (e.g., contusion), and (9) outcome (e.g., number of lost workdays). Except for the secondary source, all of those data elements were used at some point in scenario development, but no single injury grouping encompassed more than five of those data elements.

Consistent with what Lincoln et al.[11] found with the Army data, the information needed for a full descriptive taxonomy was often found in the narrative/text information, not from the coded data elements. As many of the desired data elements were not coded in the GSAS database structure, coding of each mishap was necessary to systematically create/reconstruct hazard scenarios. This event reconstruction was sometimes done within an activity—particularly for sports and recreation injuries—or by injury mechanism for industrial injuries. For the industrial injuries, the hazard scenario itself describes the motion or action being performed at the time of the injury (e.g., climbing a ladder), while a sports/recreation activity (e.g., playing basketball) must be broken down further in order to provide more precise information needed for prevention. The top-level data tables presented in this paper alternate between showing activities and injury mechanisms, depending on the circumstances of the mishap and the amount of data available. This project attempted to place each injury in the context that would provide the best information for injury prevention.

Air Force safety mishap data are generated from a web-based mishap reporting system intended for prevention purposes. This type of system differs markedly from the administrative data systems from which military enterprise medical data are derived. In the medical data systems, every medical treatment event (medical encounter) is recorded without any threshold for doing so. While the medical data for injuries receiving treatment are very complete, this type of data has limited utility for determining injury causes and mechanisms necessary to develop interventions. On the other hand, safety data provide a less complete account of injury incidence due to reporting thresholds (i.e., at the time of this study—a minimum of 1 lost workday) that preclude documentation of injuries of less severity. The reporting process itself can impose another obstacle to documentation as supervisors and managers have to notify base safety officials who, in turn, have to investigate the mishap and subsequently write and submit the report. Thus only the most serious mishaps conforming to the DoD guidelines are likely to be reported for a particular class of event.

There are few surprises in the top activities generating lost-workday injuries in airmen. The top activities and mechanisms for injuries to airmen were consistent with medical data,[1,2,12] with vehicle operation/riding, slips/trip/falls, and sports among the leading causes of injury mishaps. As with other studies of injuries in the military, motor vehicle mishaps were found to be among the most frequent causes of serious injuries.

Table 5. Predominant functional areas generating lost duty day unintentional injuries in USAF civilian employees, 1993–2002

Rank by total lost workdays	Functional duty area	# lost duty day injuries	Lost workdays per injury (M/median)	Reported injuries (%)
1	Aircraft maintenance	3,311	7.2/3	31
2	Services/MWR	2,243	7.3/3	21
3	Civil engineering	2,085	9.0/4	20
4	Other	821	8.4/3	8
5	Supply/logistics	513	7.5//3	5
6	Transportation	308	8.8/5	3
7	HQ/base command and administration	207	8.9/4	2
8	Medical services	184	9.7/4	2
9	Communications/computer operations	172	9.7/4	2
10	Personnel	159	7.4/3	2

HQ, headquarters; MWR, morale, welfare, recreation; USAF, U.S. Air Force

Slip/trip/fall injuries are second only to the vehicle/equipment-related injuries in their contribution to the active duty lost-workday injury problem. On the civilian employee side, this is the primary injury mechanism. While most (60%) of the military injuries are on-base and/or industrial, the remainder occur off the installation. Unlike motor vehicle–related mishaps, off-base slip, trip, or fall injuries to airmen can occur in multiple ways and in the most commonplace circumstances. Thus, these may be more resistant to USAF control than motor vehicle mishaps. Of course, the fatality rates are higher for the latter, so those should continue to receive a considerable share of the attention. While the active duty transportation/vehicle-related mishap problem has received substantial attention, it should be noted too that civilian injuries in the Transportation functional area have generated the highest median number of lost workdays per injury: 5 days. This indicates that the severity of these injuries is substantial, and thus they are another viable target for injury reduction.

A secondary analysis (not shown) shows that active duty industrial injuries as reported through GSAS occur at a very low frequency that appears to be declining. Yet, enough of these injuries continue to occur that they too represent viable injury reduction targets, particularly in the aircraft maintenance and civil engineering sectors. Civilian employee injuries occur in those same functional areas along with Services/Morale, Welfare and Recreation, a sector that represents a variety of disparate job settings, for example, child care centers, fitness centers, and food service operations. Many of these were slips, trips, and falls.

Except for trail riding, about three quarters of the sports and recreation injuries occurred on-base, but not necessarily on-duty. Injuries occurring during the duty day are officially classified as "on-duty" for legal line of duty determination; however, for the purposes of this analysis, these injuries were categorically labeled as "off-duty" given that no airmen's principal job is to play a sport regardless of the time or location. Some exceptions probably occurred (e.g., training for interservice tournaments and perhaps some unit training) but the vast majority was likely to be purely recreational in nature.

A key consideration for the injury reduction mandate is the degree of control that the USAF has over the circumstances surrounding the injury-producing mishaps. About four of every five lost-workday injuries to airmen occur off-duty, and this presents a challenge for which easy solutions do not exist. Conversely, activities and mechanisms that are predominantly on-base in their occurrence represent some of the best opportunities for direct intervention by commanders.

The relatively high mean value for each, along with their high frequency of occurrence, indicates that moderate to severe injuries occur down at the base of the injury-reporting pyramid, that is, from Class C mishaps. Therefore, Class C should not necessarily be equated with a low level of severity as is sometimes inferred. The high percentage of active duty injuries that resulted in fractures is most likely a result of the lost-workday threshold for reporting injuries. Fractures and similar severe injuries are readily recognized as such and are thus more likely to be reported by safety officials, while most injuries treated in military clinics are much less severe and not likely to be reported by commanders or safety personnel. The number of lost workdays per Class C injury and the high percentage of fractures among the Class C injuries receiving mishap reports indicate that they would be a priority for prevention.

Summary

This descriptive study of lost-workday injuries used newly developed methods to identify hazardous scenarios for a wide variety of occupational and recreational activities. This project demonstrated the feasibility of applying an approach advocated by Lincoln et al.[11,13] and Drury et al.[6] No analysis of this type has been done previously in the USAF, so those scenarios shown in the companion papers[2–5] provide valuable insight into how injuries associated with occupational and recreational activities might be prevented. Effective and efficient injury prevention efforts depend on not just a knowledge of the general activities (e.g., material handling, falls, basketball, softball) associated with injuries, but also the specific hazardous circumstances. Hazard scenarios have been explored in greater depth in companion papers.[2–5] Air force safety data clearly have value for the injury-prevention process. The value can be enhanced not just by coding and aggregation as done in this and companion papers, but also through linkage with medical and personnel data as done by Ruscio et al.[12] The first step of prevention is knowing what the biggest problems confronting a population are; the second step is to find what causes the problem.[1,2] The safety data examined in this report contribute each of the first two steps. (Table 5).

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