Descriptive Epidemiology of USAF Lost Workday Injuries, FY93-FY02

Part I. General Trends and Summaries

Research and Epidemiology Branch

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Introduction

Lost workday injuries (LWI) will soon be under formal surveillance across the military services. Progress towards reducing LWIs within each service branch will be measured according to a series of metrics that are based exclusively on administrative medical data (outpatient and inpatient) from the Defense Medical Surveillance System (DMSS). The Secretary of Defense's guidance on the reduction targets challenges the military services to "at least a 50% reduction over the next 2 years"[1].

The published literature on military injuries in general is plentiful, yet little information has been published regarding LWIs in particular. Most published material pertains to fatal injuries, or Class A mishaps (fatal or permanently disabling injuries) in the Safety arena. However, almost all LWIs are non-fatal, non-disabling [2], thus they fall within the Class C category (lost duty/work time only). Understanding the epidemiology of LWIs is necessary to reduce the frequency of these injuries, i.e., planning a prevention program.

The 50% reduction goal may turn out not be realistic for the Air Force. We already know that our rates are lower than the other services and the incremental effort required to halve our already low rate of LWIs may not be practical. This challenge is complicated further by the fact that 56% of USAF LWIs occur off-duty and 44% occur off-base. This study will help Safety and Medical leaders to understand LWIs at a level of detail much greater than a mere metric, and will provide a reality check on the feasibility of meeting the DoD goal.

Methods

SEPR pulled ground mishap reports for which one or more lost workdays were indicated. Flight data were excluded because the existing coding of these

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[1] "Reducing Lost Time Due to Injuries: An Integrated Approach" (briefing), 26 Mar 03; SECDEF memorandum UO6916-03, Reducing Preventable Accidents, 10 May 03

[2] Our analysis indicated that only 45 out of the 32,812 (0.1%) were fatal or permanently disabling, i.e., Class A mishaps

electronic reports does not allow one to identify which person(s), among several listed people who may be associated with a multi-person mishap, sustained the lost workday injury. We estimate that using only ground data undercounts LWIs by 1%-2% at most.

Also excluded from analysis were fatal injuries in which death was immediate or when a person was medically retired (since lost workdays = 0) due to a prognosis indicating imminent death or certain permanent disability. Those injuries in which workdays were lost before the person died--situations where there was some expectation of recovery and the person was not immediately retired--were included in this analysis (n = 10). This selection criteria resulted in a data set that was overwhelmingly reported from the Mishap Class C category, not the immediately fatal (Class A) or disabling (either Class A or Class B) mishaps.

We also excluded military personnel assigned to the AF Reserves Command (AFRC) or Air National Guard (ANG) from the analysis since we had no active duty-time denominator for those groups. This categorical exclusion assumed that all such assignments indicated that people were actually Reserves or ANG component members. We understand that this assumption was not valid in all cases since some Reserves/ANG members are assigned to an active component command (e.g., ACC) and vice versa (e.g., Active Duty airmen assigned to AFRC). But, these situations are the exception, not the rule; no other method exists in the mishap data on which to remove part-time personnel from the rate calculations.

The following categories of personnel were also excluded from this study: cadets, foreign nationals, Youth Opportunity Program workers, non-U.S. military, non-Air Force military, and contractors. Injuries in those groups would either be non-reportable according to federal law, a group for which the Air Force is not officially accountable, or a group for which we could not find accurate census data (denominators). This study does, however, include both Department of the Air Force civilians and military paid from non-appropriated funds (NAF).

We recoded thousands of records into activities more consistent with the *International Classification of Diseases* (ICD) system of coding for external causes of injuries. We used the combination of existing coded data fields for injury subcategory (e.g., personal motor vehicle or sports and recreation), activity (e.g., operating, playing flag football), and narrative text searches to create discrete ICD-like categories.

Safety data strengths and limitations

Safety mishap data from which injury information is extracted is generated from an event-based reporting system, not an administrative data system that records transactions such as medical in-patient visits. Supervisors are required to report mishaps if the mishap meets the reporting criteria in Air Force Instruction 91-204, *Safety Investigations and Reports*. For lost workday injuries, the primary reporting criterion is that the airman or worker must have lost at least one duty/work day. The definition of "duty day" for airmen has generally followed the traditional Monday through Friday schedule used by civilian employees, thus many injuries to airmen that would otherwise have caused missed duty time are not reportable provided these airmen can report for duty the following duty day, usually on Monday.

The reporting system is mostly passive in that it depends on someone, the supervisor or commander in this case, to comply with AFI 91-204 and report the mishap to their safety office. Furthermore, base safety offices need to investigate the mishap to some extent, and then electronically transmit the mishap report to Headquarters, Air Force Safety Center. This method of reporting is consistent with many medical surveillance systems that readers may be more familiar with. An active component exists too, as base safety officials commonly investigate mishaps that they become aware of even without supervisory notification. This frequently occurs with motor vehicle crashes for which Safety officials are routinely notified by local law enforcement authorities, not the supervisor or commander.

Another limitation is that not all USAF personnel are included in the surveillance/reporting network. Mishaps involving airmen assigned to non-AF units (e.g., joint or unified commands, DoD agencies, etc) are not reportable. In essence, reportable mishaps are categorically those that impact *Air Force operations* through lost duty time or worse (disability or death). Thus, the safety data are narrower in population coverage than administrative medical data that hold clinical encounters on every airman who receives treatment for an injury related condition anywhere in the worldwide network of military or military-contracted facilities.

Safety data are based on events (termed mishaps), thus the injuries within these events are new, or incident, injuries. This means that an incidence rate can be calculated on the reported injuries, i.e., a frequency of occurrence. The reporting system systematically excludes an unknown fraction of incident injuries because they are either not reportable or are not reported when they should be, but that fraction is assumed to be consistent over time. While we may be underestimating the actual incidence of injuries in the USAF, the time-series trends are valid under the above assumption. The lone threat to the assumption of consistency has appeared subsequent to the launch of the Air Force Safety Automated System (AFSAS) in FY00. As expected and intended, the rate of reported mishaps increased due to high user acceptance of the new reporting system. We have accounted for in the analyses presented below.

If we had instead used medical data for this investigation, the vast majority of all injuries of both medical and operational significance would have been in our data set. However, we also would have included many "injury-related medical visits" that were *not* incident injuries. Medical data are based on medical visits, not events, thus one injury can generate multiple visits. Coding of these medical visits is also problematic since the ICD coding system fails in some instances to distinguish between "acute" (i.e., newly occurring) injuries, chronic musculoskeletal conditions, and the late effects of a past injury.

As a means of relative comparisons between safety data and medical data, safety data are "deep but narrow" while medical in- or out-patient data are "shallow but wide". Depth indicates the amount of information available on the external causes and circumstances surrounding the injurious mishap while width indicates the proportion of the population covered by the surveillance network and the degree to which all injuries in that population were captured in the data. Medical data has been deemed by the DoD working group on lost workday injury metrics to be more suitable for surveillance than safety data; however, the medical data provide few details on how these injuries may be prevented. Our use of safety data has allowed us to describe external causes and activities with far greater detail than medical data will allow.

In conclusion, the analyses presented here on lost workday injury trends are likely valid. Base safety officials validate the information on the external cause and circumstances of these injuries locally, so there is no reason to doubt the accuracy of these reports. Safety data are the only sources of such prevention-relevant information, thus the information that we present is both new and relevant to the subject of lost workday injuries.

Chapter 1. Combined Military and Civilian Trends

The total number, or burden, of reported lost workday injuries in the Air Force was significant, but the actual rate or frequency at which lost workday injuries and lost workdays accrued was relatively low. Military personnel contributed 3.7 million person-years to the analysis while civilians contributed 1.8 million person-years[3].

Military and civilian members incurred 32,812 lost workday injuries, producing an incidence rate of 5.9 injuries per 1,000 worker-years. The 10-year civilian and military rates were nearly equal although each rate followed a different trend throughout the period (discussed below). Civilians lost a total of 83,392 workdays in 10,563 injuries over the 10-year period while the military's 22,249 injuries produced 171,202 lost duty days. This loss in *each* group was equivalent to losing about 40 full-time workers or airmen each year during the period (i.e., 40 worker-years) or, equivalently, 2.2 workers for every 10,000 Air Force workers, each year. The male LWI rate of 6.5 per 1,000 worker-years was 1.21 (95% confidence interval = 1.18, 1.24) times higher as the female rate of 5.4/1,000. Assuming no occupational or behavioral risk disparities over time, each civilian worker or airmen entering the workforce in 1993 had a 6% probability of sustaining a LWI injury over the following 10 years.

Lost Workday Injury Incidence Rates

The non-linear trend model seen in **Figure 1** shows that the combined military-civilian LWI incidence rate declined over the first half of the 10-year period, and has since flattened out. During the earlier years of the period, the rate decreased linearly. The slope of this trend line through FY99 indicated a 2-year reduction of 1 injury per 1,000 personnel (0.48 per each successive year); however, this trend ended abruptly in FY00. This is also when the Air Force launched its new Safety Automated System (AFSAS) in ground safety operations. This system was designed to make reporting easier, and it actually may have worked that way, increasing the rate. This will be discussed in more detail below.

[3] Note: a person-year or worker-year is one person working for one year, approximately 210 working-days per year.

The LWI trends of military and civilian behaved differently when analyzed separately (**Figure 2**). The trends followed quadratic patterns (curved) not straight-line (linear), so a simple statistic for the yearly rate change is not valid. However, the civilian rate conformed nearly as well to a linear model in which the rates declined throughout the period by 0.4 injuries per 1,000 each year or, equivalently, 1.2 injuries/1,000 every 3 years. The military rate trend, however, clearly followed a U-shaped pattern.

A rate spike occurred in both groups in FY00, possibly due to AFSAS. The civilian pre-AFSAS trend of the annual rate decrease was -0.6, about the same as the post-AFSAS trend of -0.7. This similarity in trends supports the theory that AFSAS' effect shifted the entire trendline upward (**Figure 3, civilian only**) as indicated by Δ (trendline shift or delta). In other words, perhaps a sudden increase of the true (but unknown) rate did not occur, only the rate at which these injuries were *reported*. If so, a new baseline was established in FY00 with the advent of AFSAS. Breaking the study period down into pre- and post-AFSAS periods, the post-AFSAS 3-year trends looked like this: the civilian rate declined annually by 0.7 injury/1,000 (shown in Figure 3, statistically significant) while the military rate (not shown, not statistically significant) increased slightly each year by 0.1 injury/1,000.

Figure 1. Overall 10-year trend in the LWI incidence rate, combined military and civilian

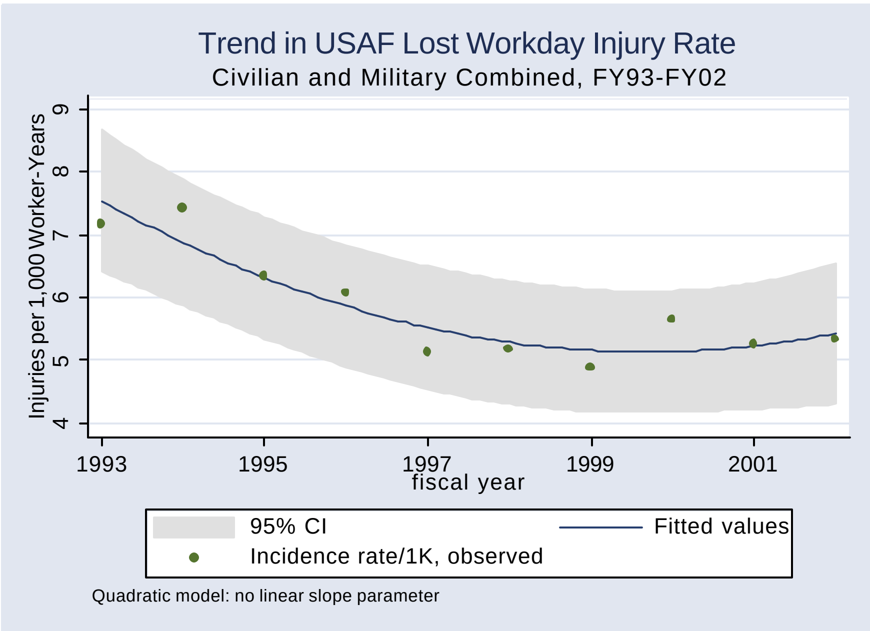


Figure 2. Trends in LWI incidence rates, civilian vs military

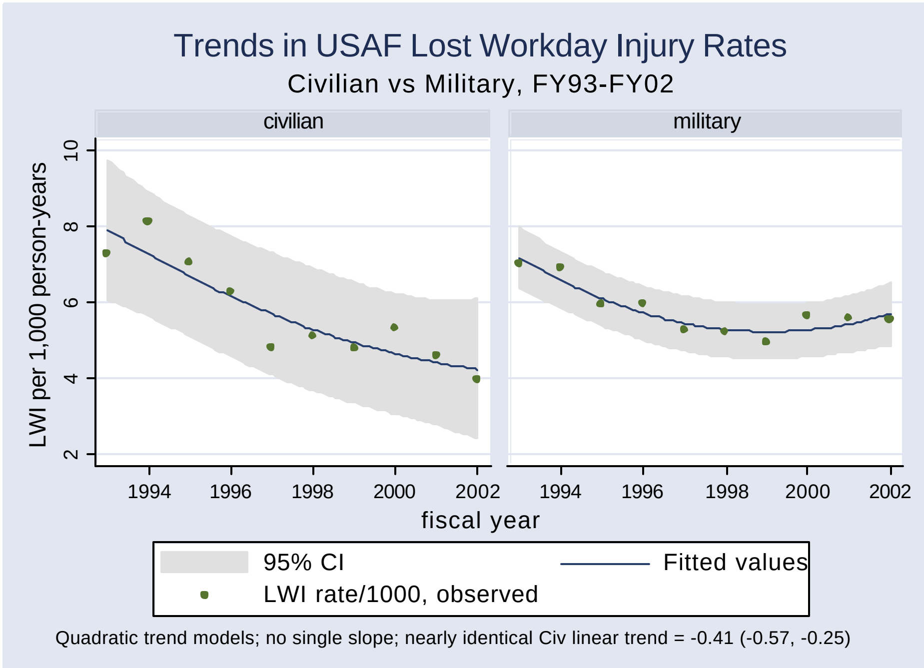
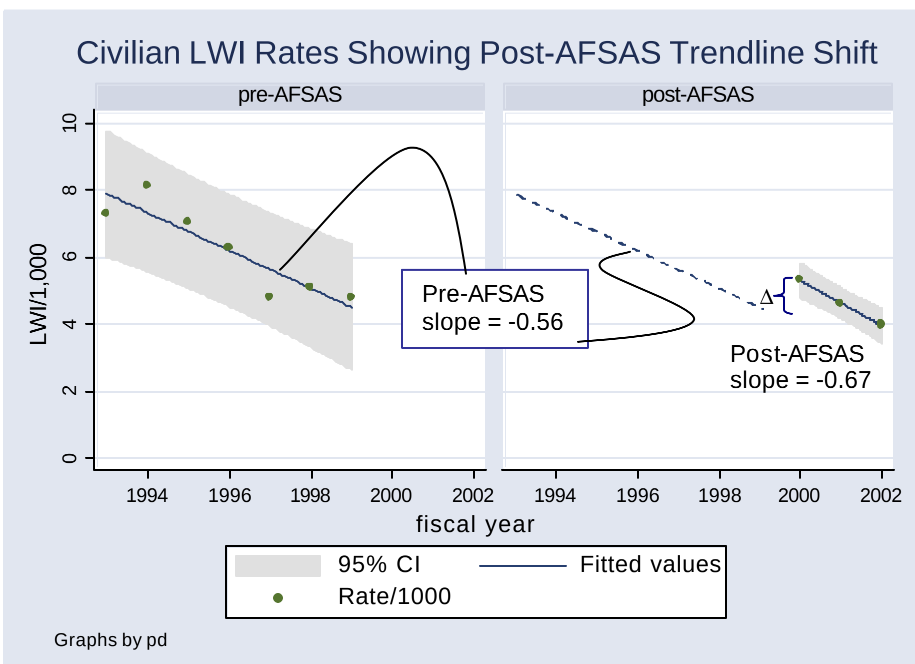


Figure 3. Civilian LWI rates from Figure 2, showing discrete pre- and post-AFSAS linear trends

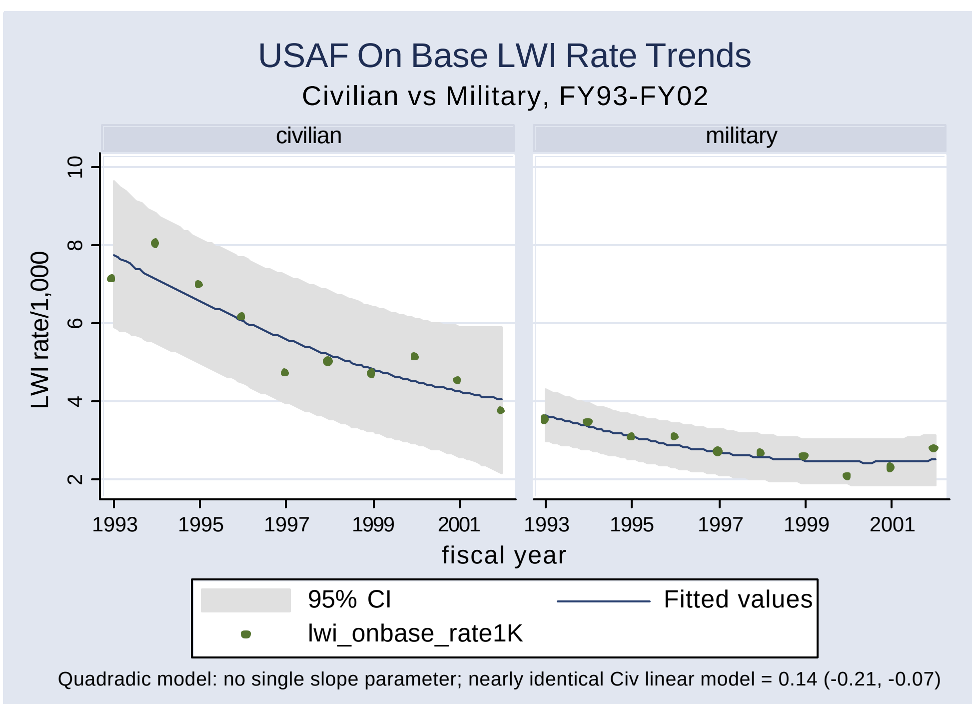


For the military, 52.4% of LWIs occur off-base while only 2.3% of civilian LWIs occur off the installation. Military off-base LWIs are overwhelmingly off-*duty* as well. Civilian off-base LWIs are quite the opposite: mishaps occurring *off* the installation are only reportable under DoD policy if they occur *on* duty. This occurs when civilians are attending off-base training or they are otherwise on TDY and the mishap occurs off a military installation.

On-Base Comparison. For a more fair comparison of civilian vs military LWI rates--and to assess that part of the overall rate over which the Air Force has significant control--we computed and compared rate trends for the *on-base* LWIs only (**Figure 4**). Unlike the trend/curve shown in Figure 2, the on-base-only trend for the military was similar in appearance to the civilian curve. The military trend, however, flattened out in recent years. The most significant difference between military and civilian curves is that the military trend started off and remained about one magnitude lower than same-year civilian rates. The most current (FY02) civilian rate is about as low as the military rate was 10 years ago.

The civilian on-base LWI rate jumped 9% from FY99 to FY00. The military rate, however, did not spike in FY00 as seen in the combined on- and off-base charts (Figure 2), even after the AFSAS launch. This suggests that, after taking the impact of AFSAS on reporting into account, an even more substantial decrease occurred in the on-base military LWI rates than the one shown in Figure 4. If we use FY00 to anchor a new baseline for civilian trends as Figure 4 supports, we should treat the military trends likewise. The result of splitting the trends into pre- and post-AFSAS components is discouraging for the military since the post-AFSAS trend, if graphed, would slope upward (not graphed, but see Figure 4).

Figure 4. Trends in on-base LWI rates, civilian vs military



On-Base Rates. When civilian and military on-base LWIs are combined, the slope of the trend line decreases by 0.27 injuries per 1,000 worker-years each year (data not shown). After 2 years, this trend applied across the board would reduce the rate by only 0.6 injury/1,000 from the FY02 LWI rate of 3.12/1,000--the baseline rate for further comparison in DoD metrics--to 2.50/1,000. The desired 2-year 50% reduction target is 1.55/1,000.

While we realize that the DoD metric is based on both on- and off-base LWIs, we analyzed the on-base fraction of LWIs separately to make a point. Reducing the on-base LWI rate should be easier than controlling the vast and seemingly random set of circumstances that would reduce the off-base rate. If achieving the metric goal for the on-base rates is challenging, the prospects to reduce off-base LWIs and the overall rate seem even less plausible. Other SEPR analyses indicate that off-duty (largely off-base) mishaps are increasing while on-duty (largely on-base) mishaps are decreasing[4], so the likelihood of meeting the reduction target seems low under safety programmatic *status quo.*

Off-Base Military Rates. On the contrary to the logic presented above, the military off-base LWI rates appear to be decreasing *if* we accept FY00 as a new baseline for trend analysis (**Figure 5**). Otherwise, the pattern suggests that those rates spiked in FY00 and have remained on a 3-year plateau, stabilizing at 3.3 injuries/1,000 person-years after FY00's rate of 3.8/1,000, the highest during the 10-year surveillance period.

Accepting FY00 as a new baseline for the moment, the pre- and post-AFSAS trends are remarkably similar (they were statistically equal) as indicated by the two negative slope coefficients. The 3-year post-AFSAS trend is, by itself, too brief to be statistically significant, but the similarity in the slope coefficients adds statistical credibility to the post-AFSAS trend. That similarity suggests that the pre-AFSAS trend has continued but, however, at a higher rate due to the shift in the trend line (Δ). That shift was statistically significant, meaning that the rate of reporting definitely increased post-AFSAS. Whether or not "higher rate of reporting" is synonymous with "higher rate of mishaps" or only that post-AFSAS reporting is more complete cannot be determined using safety data alone.

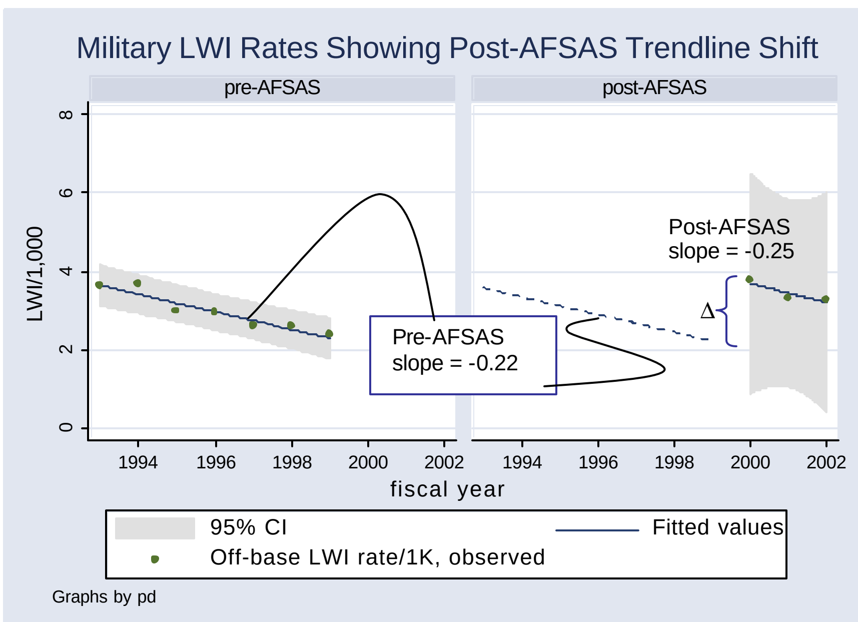
Based on the FY02 military off-base LWI rate of 3.26, that rate would need to decline by (and to) 1.63 injuries/1,000 in 2 years to meet the DoD goal. If we use the more robust trend seen in the pre-AFSAS period (-0.22 injuries/1,000/year),

[4] Air Force Safety Analysis, 1993-2002; pg 32

the projected rate in FY04 would be 2.82, far short of that goal. That projection, along with the other projections in this analysis, is based on the assumption of safety program *status quo*--not undertaking any additional mishap prevention initiatives or programs. For certain, the Air Force Safety Center has no intention of hovering at *status quo*.

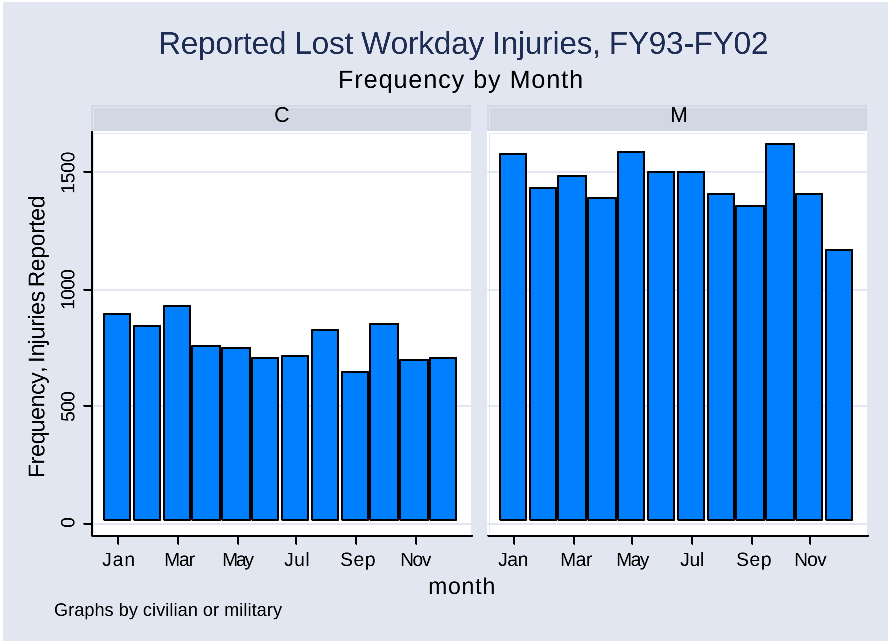
Despite the off-base trend in the desired direction, any attempt to reduce the overall LWI rate by any percentage would be held hostage by those off-base rates. They represent 44% of the overall rate and are logically more resistant to Air Force control measures. The root causes of these injuries are likely based more on socio-behavioral factors than things that supervisors and commanders can actually observe and influence to a large degree.

Figure 5. Military off-base LWI trends by pre- and post-AFSAS period, indicating a trend line shift



Seasonality. LWIs followed no significant seasonal trend in either demographic category (**Figure 6**). The remarkable features in Figure 6 are few. One item of note is the difference between civilian and military LWIs throughout the period. October was one of many peak months for both civilians and military, as reported injuries declined in November and December. The post-October injury drop-off occurred more suddenly in military personnel, but this decrease was relatively small compared to the more gradual civilian decrease through the end of the calendar year.

Figure 6. Seasonal trends in LWIs, military vs civilian



Lost Workday Rate

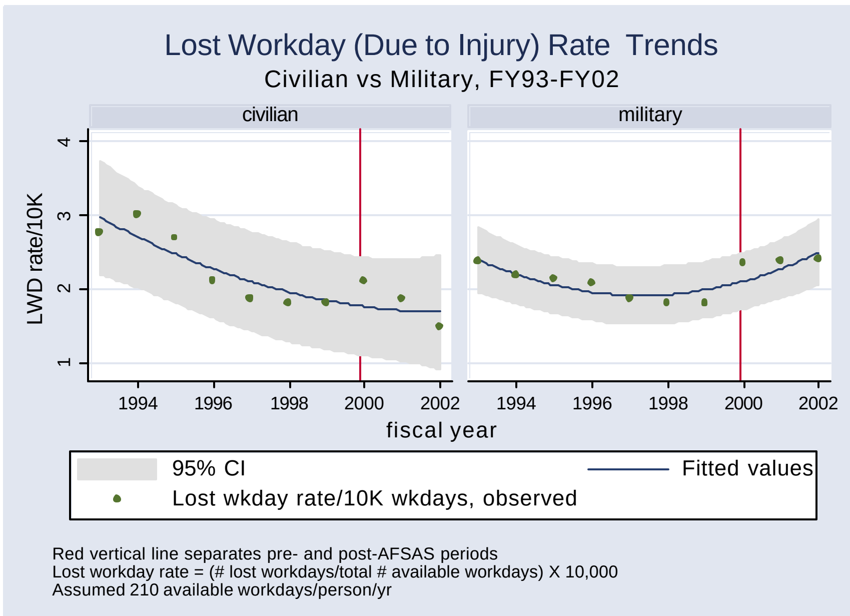
The injury-related lost workday (LWD) rate[5] has steadily decreased in civilian workers, but that decrease has flattened out more recently (**Figure 7**). The military LWD rate has followed a U-shaped trend: it decreased until FY00, and then the rate suddenly increased. Both of the trends are quadratic, meaning that no single slope (or annual change) is valid. AFSAS again comes into consideration, particularly on the military rates. The newfound ease of reporting mishaps accounted may have accounted for the 34% rate increase (from 1.81 to 2.42) from FY99 to FY00. Civilian rates also increased moderately in FY00, supporting the hypothesis that the rate increases were each an artifact of implementing AFSAS. As seen above, we probably need to establish a new baseline for trend analyses, particularly for the military, beginning in FY00 (data not shown).

In a split look, the military lost workday rate not only broke away from the pre-FY00 linear pattern, but the direction of the trend reversed as well--a positive

[5] Lost workday rate, or lost workday incidence rate, is not the same measure as the lost workday *injury* rate. The lost workday rate is based on the actual number of lost workdays divided by the total number of available workdays, not the rate or frequency of the events (injuries) themselves

(i.e., bad) current trend in which the LWD rate is increasing by 4% each year (see Figure 7, post-AFSAS to the right of the red lines). The explanation for the rate surge in FY00 and the subsequent plateau is an increase in motor vehicle and motorcycle-related mishaps that produce injuries of relatively higher severity, resulting in more lost workdays. The aforementioned enhanced reporting via AFSAS is another likely reason for the rate increase.

Figure 7. Total lost workday rate, trends by FY

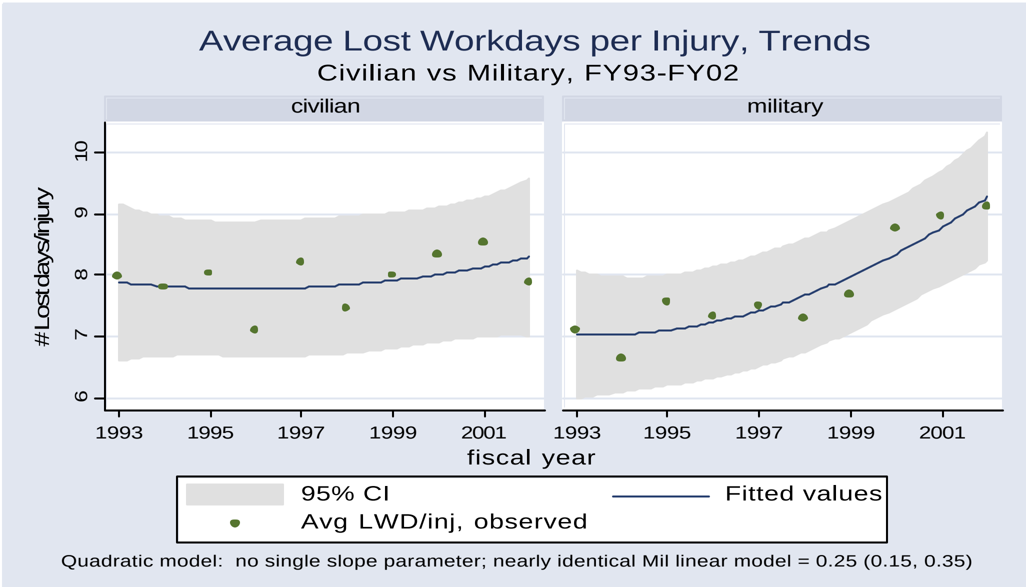


Lost workdays per injury (injury severity)

Figure 8 indicates that the average number of lost workdays per injury increased significantly in the military group over the past 10 years. Should this trend continue the average number of lost duty days per injured airmen would continue to increase by one day every 4 years. This quadratic (curvi-linear) model provides a very good representation of the actual observed averages (R^2 = 0.86). The surge in FY00 is not likely the result of AFSAS but rather that those injuries were related to motor vehicles, injuries of greater severity.

The civilian trend did not conform to linear model. The best-fitting model, a quadratic one presented in Figure 8, still did not depict the observed averages very well (R^2 = 0.18). If anything, the trend appears to be turning slightly positive, but another 2-3 years of data will be needed to verify that trend.

Figure 8. Average lost workdays per injury



Chapter 2: Activities and Functional Areas Associated with Lost Workday Injuries

Injury-Producing Activities

Figure 9 shows the top 12 activity generators of lost workdays along with the number of injuries reported for that activity and the percent of each activity's injuries that occurred on base. **Table 1** lists the same data, but also includes the average (mean) and median numbers of days lost per injury along with recent statistical trends. The listing represents 12 of the 128 possible injury-generating activities and 60% (19,717/32,812) of all LWIs that occurred during the period. Of the 116 non-listed activities, 76 totaled fewer than 100 LWIs each over the 10-year period. Eight of the 12 activities were associated with on-base injuries (in bold). Three of those 8 were off-duty sports and recreational activities (SR), almost entirely in military personnel. When SR activities are combined with the predominantly off-base activities, a significant fraction of LWIs were associated with activities that are only partially controllable, if not completely *un*controllable, by USAF policies and practices. Also, the off-base activities tend to generate a higher number of lost workdays per injury on the average.

Figure 9. Top 12 injury-producing activities with numbers of injuries broken down by on- and off-base fractions

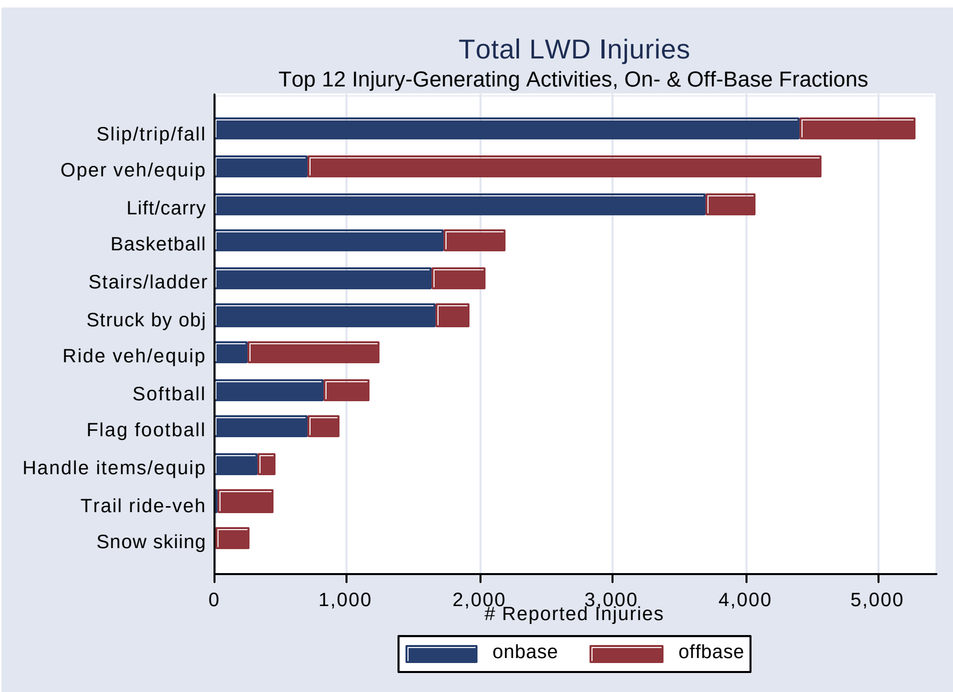


Table 1. Total lost workdays, total reported injuries, and average days lost per injury, top 12 specific external cause or activity categories only, sorted by total lost workdays*

Rank	Activity	Total lost wkdays	Total injuries reported	Lost wkdays per injury: Mean / Median	On base percent	Recent trend
1	Operating vehicles or equipment	49,035	4,580	10.7 / 3	15.5%	3-yr plateau
2	**Slips, trips, & falls (STF)**[†]	42,147	5,283	8.0 / 3	**83.5%**	Steady
3	**Lifting/carrying (non-STF)**	24,940	4,085	6.1 / 3	**90.8%**	Declining
4	**Climb/descend stairs or ladder**	17,371	2,048	8.3 / 3	**79.9%**	Declining
5	Riding in or on vehicles or equip	14,079	1,247	11.3 / 4	20.9%	Increasing
6	**Playing basketball**	12,765	2,204	5.8 / 2	**78.5%**	Steady
7	**Struck/struck by object** [‡]	11,298	1,930	11.1 / 5	**86.4%**	Increasing
8	**Playing softball**	6,902	1,181	5.8 / 3	**70.8%**	2-yr plateau
9	Trail riding--dirt bike/ATV/Quad	5,563	454	12.3 / 7	7.7%	Erratic
10	**Playing flag football**	5,459	944	5.8 / 3	**74.5%**	Erratic
11	**Handling items/equipmt (non-STF)**	3,452	468	7.1 / 3	**71.2%**	Erratic
12	Snow skiing	2,904	277	10.5 / 6	3.6%	Declining

* Excludes categories such as "standing" which convey only incidental activities

[†] Numerous activities were associated with this c ategory, but specific well-defined activities (e.g., STF due to playing basketball or softball, or climbing a ladder or stairs) were included in those more specific categories, not included under this general STF category. Activity breakdown: general walking (n = 2,374); stepping up or down from/to uneven surfaces such as curbs (n = 381); entering/exiting buildings or vehicles (n = 372); carrying items (n = 257); while handling or carrying items or equipment (n = 169); running–not associated with sports, jogging, or PT (n = 140); and dozens of other activities

[‡] Does not include persons being stuck by objects that they dropped; being struck by a dropped object is categorized here as dropped object; also does not include being hit by a motor vehicle (pedestrian injuries are included in lower frequency categories not included in this table)

A wide array of diverse activities is included in the STF category, thus they may be considered "non-specific" at first blush. However, our analysis of the data identified 2 major targets that safety managers can and should address immediately: plant hygiene (particularly fluids clean-up for floors) and snow/ice removal. Eliminating curbs at base crosswalks would also have a significant impact on this category.

Table 2 lists those generally less frequent activities associated with the most severe LWIs, as measured by the average number of lost workdays per injuries. Again, off-base and recreational injuries dominate the picture. Firefighting is the only activity in which injuries occur almost exclusively on base; however, parachute activity injuries all occurred on duty whether on or off the installation. Neither of those two activities is a high-frequency event, nor is either of these particularly amenable to prevention given the inherent situational unpredictability. Some percentage of the off-duty recreational skydiving and parachute jumping could have occurred under the supervision of an Air Force entity (e.g., a sanctioned non-appropriated fund organization), but they are categorized as off-base activities.

Table 2. Total lost workdays per injury--specific categories only*

Rank	Activity (# reported injuries)	Lost workdays per injury
1	Hang gliding (10)	24.4
2	Rock climbing (41)	18.2
3	Sky diving/parachute jump, off duty (52)	16.3
4	**Parachute activities, military on duty (30)**	15.9
5	Diving - not scuba/sky (31)	13.1
6	**Fire fighting (14)**	12.9
7	Trail riding, dirt bike/ATC/ATV/Quad (454)	12.3
8	Motorcycle racing (112)	12.1
9	**Electrical work - shock/burn (51)**	11.7
10	Riding on/in vehicles or equipment (1,249)	11.3
11	Handling/shooting firearms (109)	11.2
11	**Connecting/disconnecting (60)**	11.2
11	Snowmobiling (49)	11.2

Note: Predominantly on-base activities are shown in **bold**
* Activities generating at least 10 injuries in 10 years; excludes categories such as "walking" which convey only incidental activities; extremely low frequency activities excluded (e.g., sanctioned automotive racing, n = 1, 83 lost workdays; flying model aircraft, n = 3, avg 33.3 lost workdays)

Each type of activity differed in the nature of the injuries sustained (**Table 3**) and only a relative few of the activities were associated with a "signature" type of injury that represented a majority of all of those mishaps (bold print). Fractures were the dominant type of severe injury as dislocations, concussions, and other injuries with high severity occurred infrequently. Bicycling and trail riding (motorized) injuries produced the highest proportion of fractures, over 50% in each categ ory. Softball and snow skiing injuries produced moderately high percentages (40%-49%) of fractures. Fractures were in the top 3 profile in each of the 10 major LWI-producing activities, with handling items/equipment producing the lowest percentage of these injuries, 14 percent, which was still remarkable.

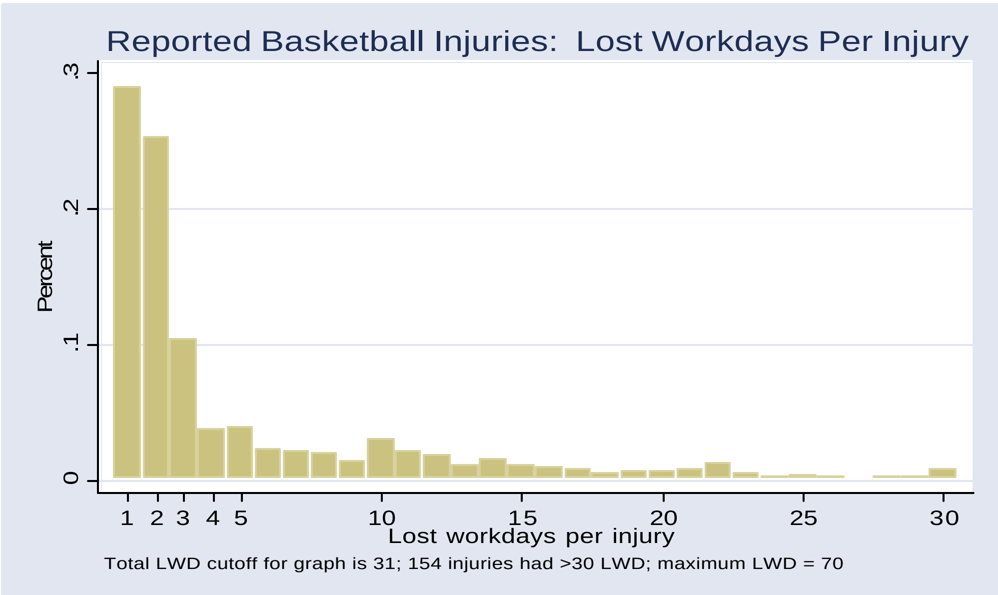
Fractures and other severe types of injuries (e.g., concussions, dislocations, tendon ruptures, etc) apparently skewed the LWD frequencies, as shown in **Figure 10**, using basketball injuries as an example. Approximately 70% of those injuries resulted in losing 5 or fewer days of duty or work. The remaining proportion (30%) correlates with the percentage of those injuries that were categorically severe (also around 30%). The maximum lost time extended out to 70 days. These extreme values that generate the right skewness also inflate the mean value. Basketball injuries averaged nearly 6 lost days per injury, but the median (mid-point) value was only 2 lost days--more in line with expectations from a "normal" basketball injury. The same effect was noted in many of the Top 12 injury-producing activities.

Table 3. Predominant types of injuries associated with Top 12 total lost workday causes or activities

		Activities' nature of injury profile		
Frequency Rank	**Activity**	**Leading**	**Secondary**	**Tertiary**
1	Operating vehicles or equipment 🏳	Fracture (30%)	Strain (30%)	Contusion (12%)
2	Slips, trips, & falls	Fracture (27%)	Strain (25%)	Sprain (18%)
3	Lifting/carrying	**Strain (86%)**	Hernia (4%)	Sprain (3%)
4	Climb/descend stairs or ladder	Fracture (31%)	Sprain (24%)	Strain (18%)
5	Riding in/on vehicles or equipment 🏳	Fracture (33%)	Strain (22%)	Contusion (15%)
6	Playing basketball	Sprain (37%)	Fracture (23%)	Strain (15%)
7	Struck/Struck by object 🏳	Contusion (27%)	Fracture (22%)	Laceration (19%)
8	Playing softball ⌖	Fracture (44%)	Sprain (16%)	Strain (15%)
9	Trail riding, dirt bike/ATV/Quad	**Fracture (60%)**	Contusion (10%)	Strain/Laceration* (5%)
10	Playing flag football ⌖	Fracture (36%)	Sprain (19%)	Strain (15%)
11	Handling items or equipment	Fracture (16%)	Laceration (15%)	Sprain (12%)
12	Snow skiing ⌖	Fracture (47%)	Sprain (23%)	Strain (13%)

* Tie
🏳 At least 5% of these injuries were concussions.
⌖ At least 5% of these injuries were dislocations

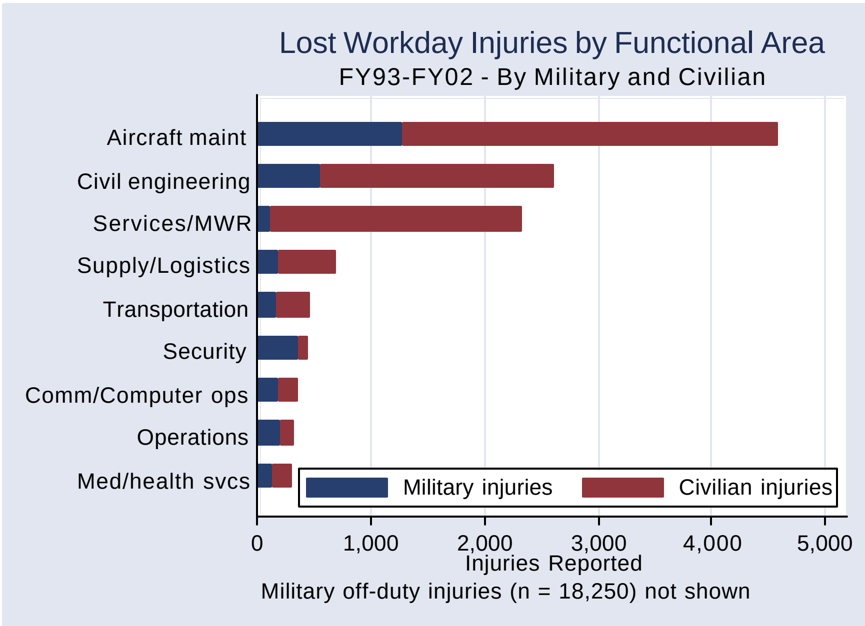
Figure 10. Proportional distribution of LWDs per basketball injury, with the right-skewness indicating higher severity



Lost workday injuries by functional area

Figure 11 shows the top injury-generating functional areas by military and civilian contributions. The same data are included with more details in **Table 4**. Off-duty military mishaps are included in the table as they accounted for 56% of the total 32,812 LWIs. Thus, the majority of LWIs in the USAF occur outside the direct influence or observation of military leaders and supervisors. Thus any LWI metric will be disproportionately weighted towards these off-duty injuries that may prove very challenging to control. Examples of functional areas not listed below are administrative functions, aerial port, missile maintenance, test and evaluation, EOD, and OSI.

Figure 11. Lost workdays by functional area showing military and civilian fractions



Future research

In a follow-on project to this one, SEPR will explore each of the injury-generating activities and external causes described here. The objective of the next report will be to stratify these activities/causes into "sub-activities" that will more precisely describe the setting or task in which these injuries occurred. We also plan to present the major types of LWIs and those activities associated with LWIs in the standard person, place, and time analytical framework.

Table 4. Predominant functional areas producing lost workday injuries with lost workdays per injury as an index of severity, and percent military

Lost workday inj rank	Functional Area	# Lost Workday Injuries	Lost workdays per injury (mean)	Percent Military
1	Military off-duty	18,250	8.0	100%
2	Aircraft maintenance	4,600	6.6	28%
3	Civil engineering	2,631	8.5	21%
4	Services/MWR	2,351	7.2	5%
5	Supply/Logistics	698	6.7	27%
6	Transportation	478	7.7	36%
7	Security	451	7.2	81%
8	Communications/Computer Ops	358	8.2	52%
9	Operations	328	8.0	63%
10	Medical/health services	321	7.6	43%

Note: 1,025 lost workday injuries were coded as "Other" in the database and are assumed to be "non-mainstream" functional areas

The project described above will take more time than it should given the amount of data entry that base safety officials perform. The mishap data are not coded in a manner that enables expedient categorization into external causes and circumstances that facilitate injury/mishap prevention. We will share our findings pertaining to the existing coding system with Ground Safety Division so they can add these to their list of functional requirements for the upcoming AFSAS revision.

Chapter 3. Occupational Injuries with Lost Workdays

Methods

SEPR conducted an earlier analysis exclusively on occupational injuries during FY92-FY02 using the same methods described earlier in this report, plus an additional step of culling out non-occupational injuries from both groups. Prior analyses over the years have assumed that injuries reported and coded as occurring on-base *and* on-duty would be occupationally related. However, a close inspection of the mishap narrative free text information shows that many of these injuries are not actually occupational in the true sense (i.e., related specifically to their job tasks). Instead, many of these occur "on the AF installation", not necessarily at the industrial[6] worksite where those job-related tasks are performed. The best example of this type of injury is when a worker or airman slips and falls on an ice-covered sidewalk somewhere between his/her vehicle and the worksite or building where his/her duties are ordinarily performed. As part of the culling process, we also excluded any on-duty sports and recreation injury, all horseplay-related injuries, and injuries associated with military physical training (PT).

The first 2 exclusions are based on the logic that nobody in the Air Force has a job that requires playing basketball over the lunch hour or engaging in horseplay in either the shop or the base swimming pool. The exclusion of military PT was, however, an issue of considerable debate. Special Forces, as one example, are required to perform physical feats in military operations that are directly related to their peacetime PT, so those injuries in pararescue jumpers and similar career fields may be legitimately occupational. The incidence of this particular situation was, however, so low that finding all of these among thousands of records was not practical. Thus, we categorically excluded PT-related injuries from the field of occupational injuries. An alternative concept would have been to accept all injuries due to physical activities as occupational in military personnel since physical fitness is an occupational requirement. Still, our intent was to determine the incidence of workplace-unique injuries that are more likely to be controlled

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[6] The term "industrial" is meant to include both the so-called "dirty" and the "clean" worksites on a given base, i.e., where people perform their occupation-specific duties. The key factor in distinguishing occupational from non-occupation was this: Is an injury of this type unlikely to occur at home or off-duty?

by supervisors and commanders since personnel are under observation during such work.

For analyses of specific AF occupational specialty codes (AFSCs), we used FY94-FY02. The Air Force significantly modified the coding system for AFSCs in FY94. Many career fields were deleted due to contracting or civilianizing of these services; some AFSCs were combined into other groups. The additional time needed to map the pre-'94 codes to the current codes was considered not to be worth the additional gain in precision, nor would the exclusion of FY92 and FY93 from the analysis compromise validity.

Results

A total of 14,668 industrial-type (occupational) lost workday injuries were reported from FY92-FY02. As with LWIs in general, occupational LWI trends differed between civilian and military. The trend in civilian injury incidence rates was significantly negative (i.e., in the desired downward direction). The incidence rate in military hovered around 1 per 1,000 worker-years and showed a statistically flat trend (**Figure 12**). A crude comparison shows that the overall civilian rate was 4.9 times higher than the military rate (**Table 5**), but that crude incidence rate ratio[7] (IRR) is not valid for all demographic groups. In females, the IRR between civilians and military nearly doubled (to 9.1 per 1,000) after we statistically adjusted the rates for the age differences between military and civilians. In males, no single adjusted civilian:military IRR was valid, as there was too much rate variability by age group. In short, male civilians had an occupational LWI incidence rate that was about 6-7 times higher than the same-age military, unless the men were 40+ years of age. In that older group of males, the civilian occupational injury rate was 12 times higher than the military rate.

The civilian-military rate disparity in older males reflects differing career paths relative to injury-prone exposures. An enlisted person of either gender would move into the supervisory/non-commissioned officer level in just a few years, with each promotion removing that person further from "turning the wrenches" on a routine basis. A civilian employee, on the other hand, may be a wrench-turner his/her entire career spanning 2-3 decades. Even those who move up to supervisory positions may have spent far longer as a rank-and-file worker than a military person of the same age. Cumulative workplace exposures to hazardous

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[7] Incidence rate ratio. Simply a ratio of rates, in this case [civilian injury incidence rate]/ [military injury incidence rate]

conditions are, as a rule, magnitudes greater in civilian employees than military members. These exposure differences likely account for the disparity in the LWI and occupational LWI rates.

Figure12. Trends in lost workday occupational injury rates, civilian vs military

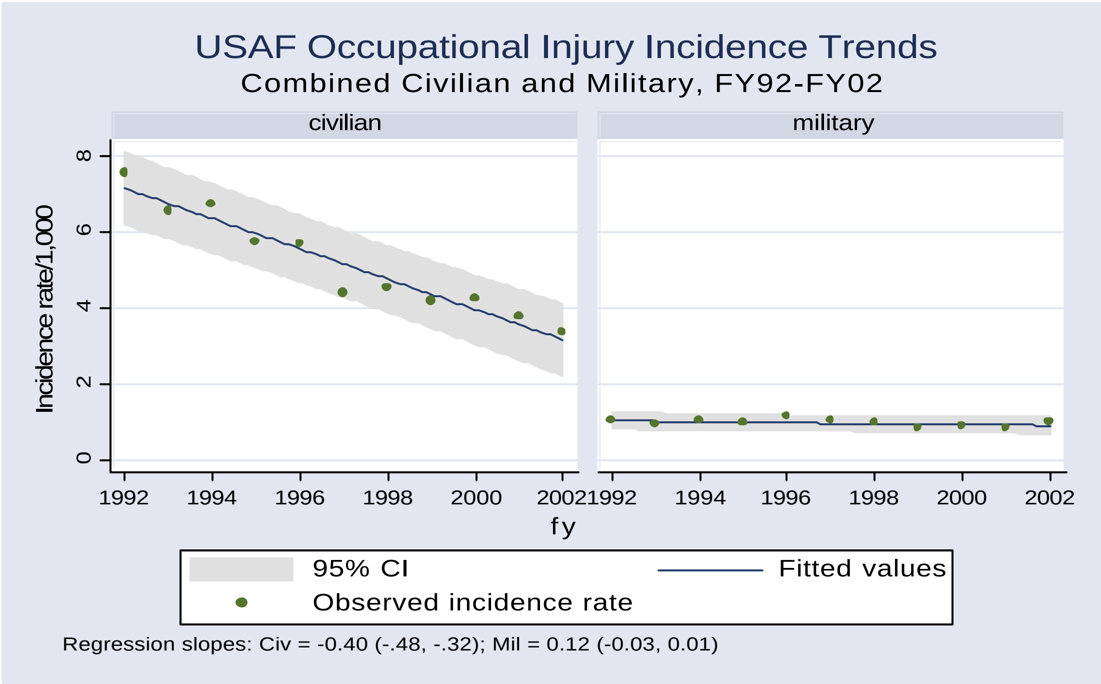


Table 5. Comparison of civilian vs military occupational injury rates using rate ratios, stratified by gender and age group with Mantel-Haenszel(M-H) estimates of adjusted rate ratios

Strata: Gender	Demographic category	Rate Ratio	(95% CI)	p value
	CIVILIAN vs MILITARY	Crude: 4.9	(4.7, 5.0)	
Females	18-24	10.5	(8.8, 12.5)	0.000
	25-39	8.5	(7.4, 9.8)	0.000
	40+	10.2	(6.8, 15.3)	0.000
M-H estimate		9.1	(8.1, 10.3)	0.000
Chi-square test for effect mod = 17.82, 2 df				0.163
Males	18-24	6.6	(5.8, 7.4)	0.000
	25-39	6.9	(6.4, 7.3)	0.000
	40+	12.4	(6.8, 15.3)	0.000
M-H estimate		INVALID	---	---
Chi-square test for effect mod = 66.5, 2 df				0.000

Cumulative traumas and the effect of aging no doubt increase civilians' susceptibility to injury and prolong recovery time, generating more lost workdays than military workers with the same injuries. In same-age comparisons, the oldest (40 and over) civilians are far more likely to be actual industrial workers than military in the older age groups. In the oldest group, military members are categorically considered supervisors, thus they receive only indirect exposures for the most part. Also contributing to the exposure disparity is the type of job itself. Many industrial type jobs formerly held by military members, (e.g., pest controllers and plumbers) have been civilianized or contracted out over the past decade. Some military members still hold "dirty" industrial jobs, particularly civilian engineering tasks during military (combat, peacekeeping, humanitarian assistance, etc) operations, but the least occupationally safe military exposures generally occur in combat training and in combat, not at a stereotypical industrial worksite. Regardless of place of occurrence, occupational injuries in airmen are relatively uncommon if not rare. However, each airman is at risk to receive an occupational injury despite the low overall risk of experiencing one. This dynamic results in a small numerator-large denominator scenario that guarantees low incidence rates of occupational injuries. Even the most-injured military career fields (**Figure 13)** experience rates that are magnitudes lower than civilian rates, both for general schedule (GS) and wage grade (WG) employees (**Figure 14)** who generally have jobs with higher occupational safety hazards.

Figure 13. USAF active duty occupational injury rates by major occupational group, 1994-2002

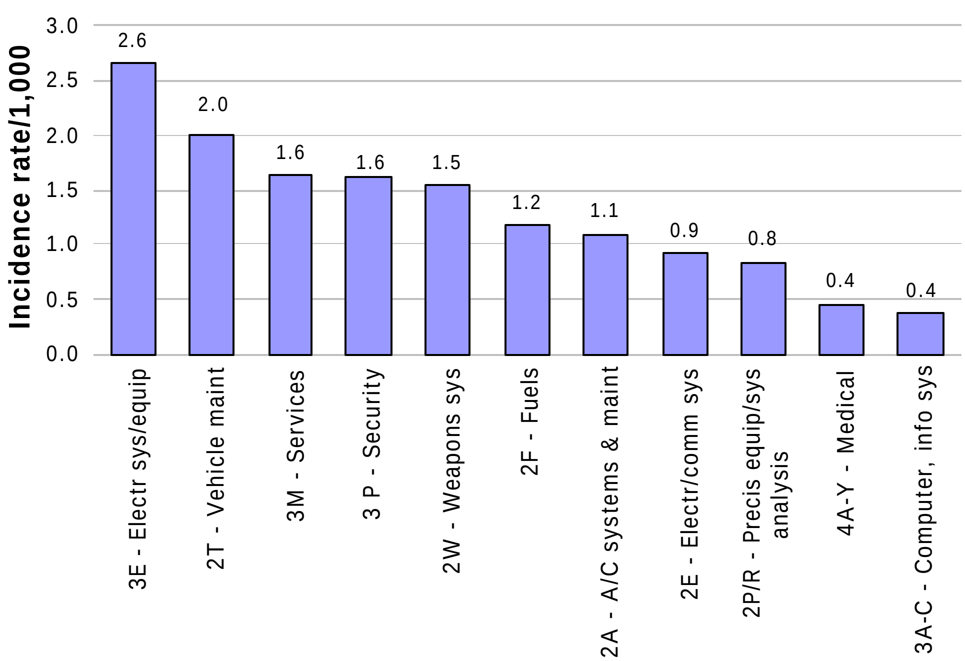
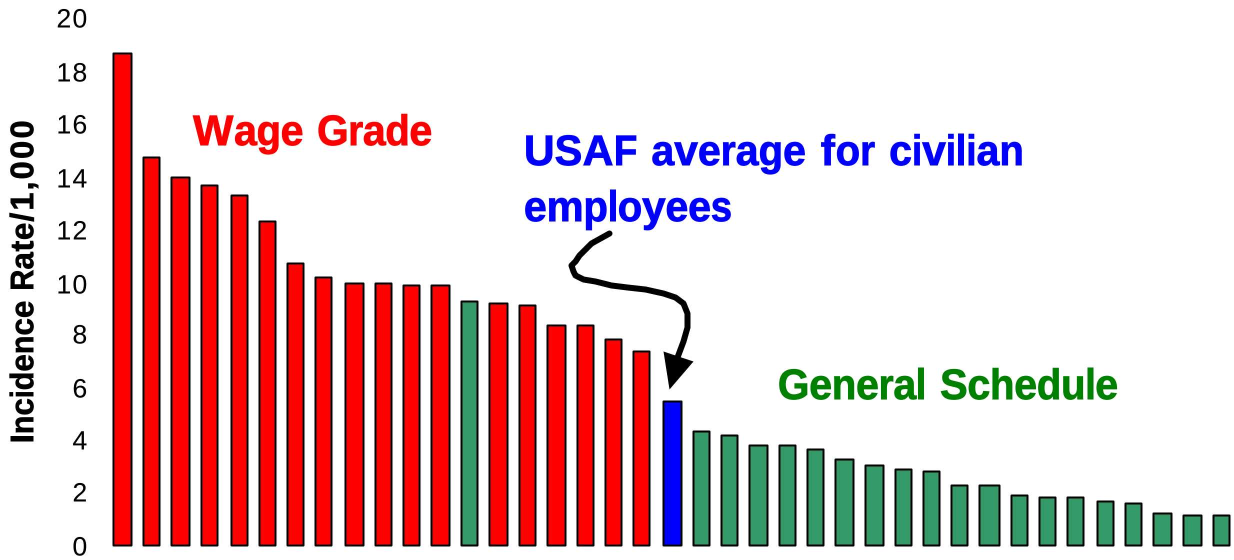


Figure 14. Distribution of wage grade and general schedule occupational injury rates, by major occupational category, and comparison to overall USAF civilian rate



General Schedule. This group had low rates overall--approximately 3 injuries per 1,000 employees each year. Fire protection and prevention employees (firemen) had the highest rates within the GS sector, over twice as high as the next highest GS category, social and recreational programs (**Figure 15**). Fireman were the only occupational group in which the occupational injury rate was higher than the overall Air Force civilian employee rate which includes the higher-risk WG employees. This difference between the overall rate and the firemen's rate was statistically significant.

Wage Grade. The average WG occupational injury rate was around 10 per 1,000 worker-years, higher than all GS categories and over twice as high as the average USAF civilian employee rate (**Figure 16**), and this difference was statistically significant. Painters and paperhangers experienced rates that were significantly higher than any other occupational WG group. The next highest risk-group tier consisted of food service workers, metal workers, woodworkers, and plumbers/pipefitters.

Figure 15. General schedule civilian employee occupational injury rates by major occupational category compared to overall USAF civilian rate

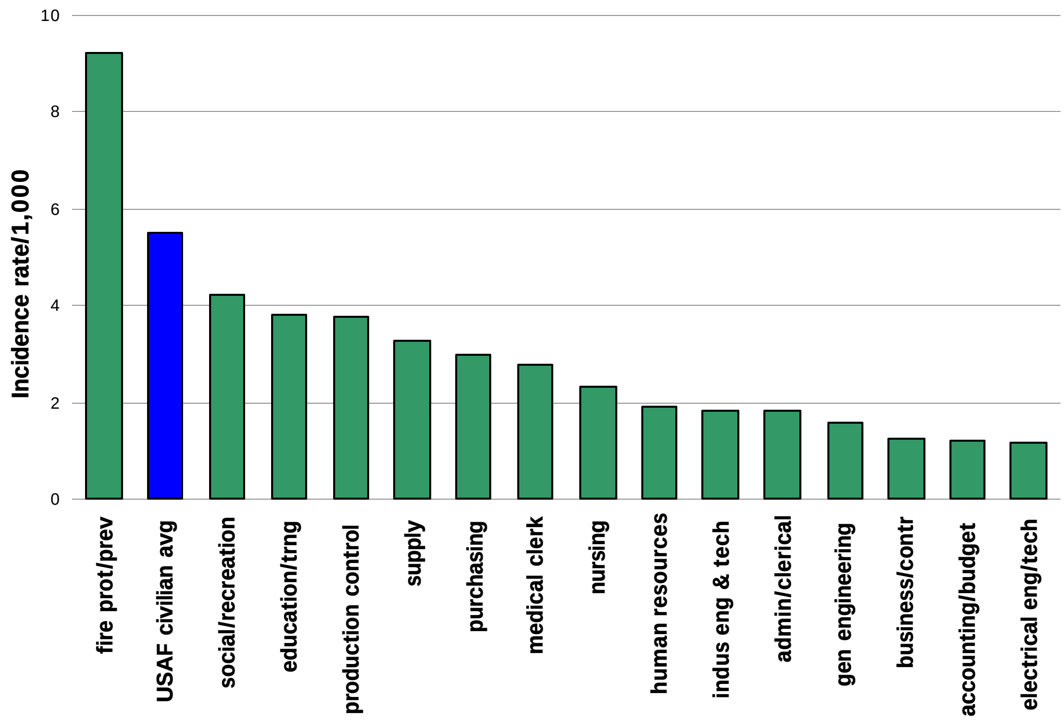
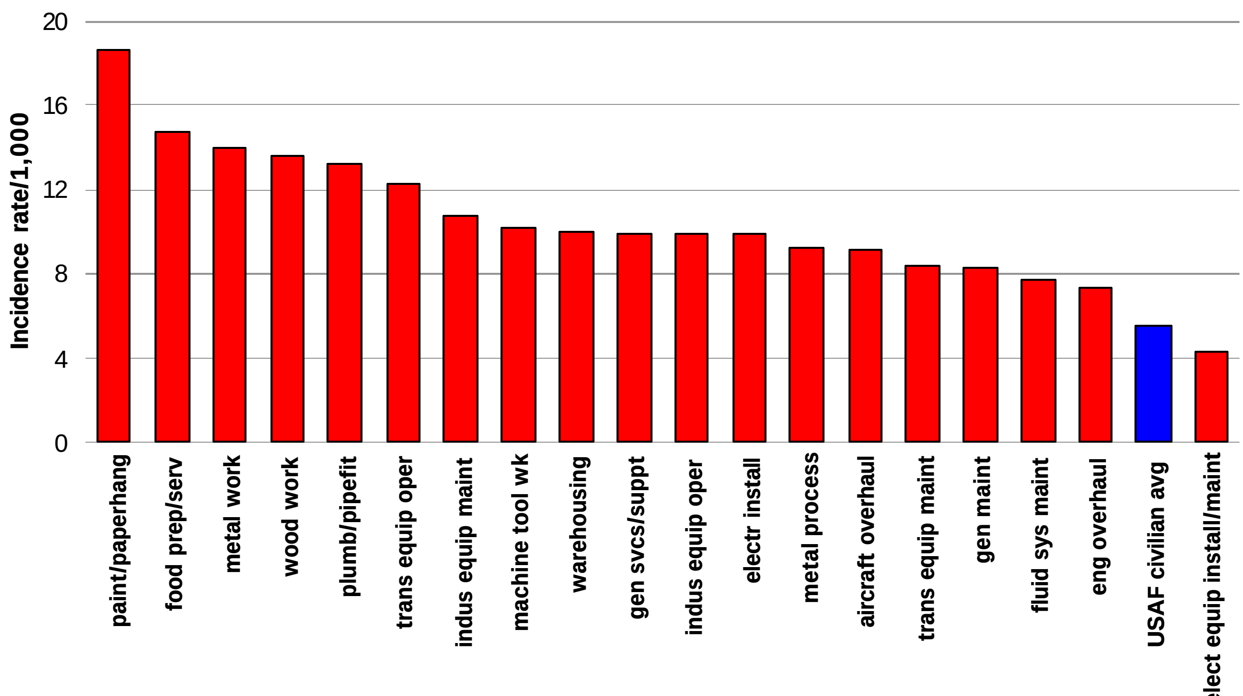


Figure 16. Wage grade civilian employee occupational injury rates by major occupational category compared to overall USAF civilian rate



Gender. Civilian occupational injuries were not distributed equally by gender, as the age-adjusted rate for females was 11% higher than the male rate (**Table 6**), which was statistically significant. Also, a slightly negative trend was present in which the female:male rate ratio attenuated slightly with age (not statistically significant).

In the military sector, the direction of the gender-based rate inequality depended on age group, so trying to use an overall adjusted measure for the gender comparison was not valid. The female rate about twice as high as the male rate in the youngest age group, but this trend attenuated in the 25-39 age group, then changed direction in the over-40 age group. This finding was surprising, as in most injury analyses (e.g., motor vehicle crashes) young males usually have higher rates than young females, likely due to behavioral differences. Perhaps in the occupational arena, the physical occupational stresses are truly the injury risk generator, not behaviors. This suggests that military occupational tasks may be designed for and better suited for males. Given the historical male dominance in the military, this hypothesis seems to be a plausible explanation. We will further probe this finding in future studies.

Table 6. Comparison of male vs female occupational injury rates using rate ratios, stratified by gender and age group with Mantel-Haenszel(M-H) estimates of adjusted rate ratios

Strata: CIV/MIL	Demographic category	Rate Ratio	(95% CI)	p value
	MALES vs FEMALES			
CIV	Age: 18-24	1.20	(1.01, 1.43)	0.043
	25-39	1.13	(1.05, 1.21)	0.001
	40+	1.09	(1.04, 1.15)	0.001
M-H estimate:		1.11	(1.07, 1.16)	0.000
MIL	Age: 18-24	1.92	(1.67, 2.12)	0.000
	25-39	1.41	(1.22, 1.62)	0.000
	40+	0.90	(0.58, 1.40)	0.639
M-H estimate:		INVALID	---	---
Chi-square test for effect mod: 17.8, 2 df				0.000

Age. The occupational injury incidence rate declined slightly from the 18-24 age group to the 25-39 age group, then increased significantly in the 40+ age group (**Figure 17**). Figure 12's *y*-axis is logarithmic to emphasize the *relative* change in the rates over age. This pattern was relatively consistent among the most frequent types of injuries, with exceptions noted in concussions that declined with age, and with both lacerations and burns occurring more frequently in the youngest age group (**Figure 18**). But, except for concussions, all major types of injuries occurred most frequently in the 40+ age group. Few military personnel engage in industrial-type work at that age, so few are injured occupationally. Civilians produce the numbers that drive those higher rates in the 40+ age group (**Table 7**). The average age at injury of a civilian employee was 43 years, compared to 26 years for injured military personnel (data not shown).

Figure 17. Occupational injury incidence rates by age group, military & civilian

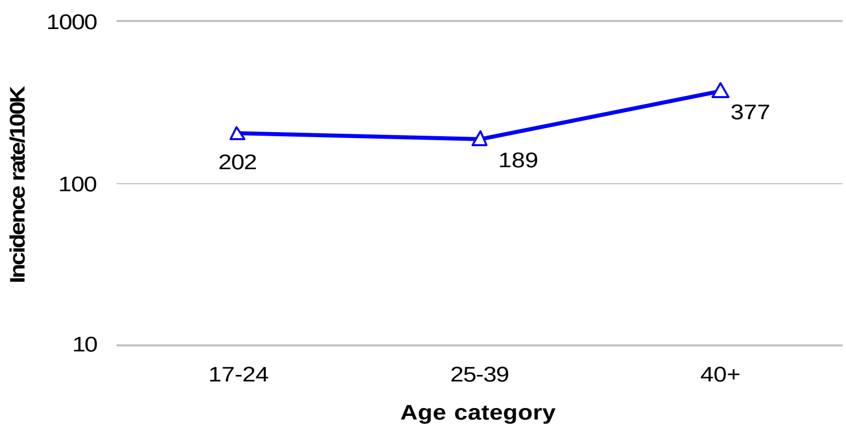
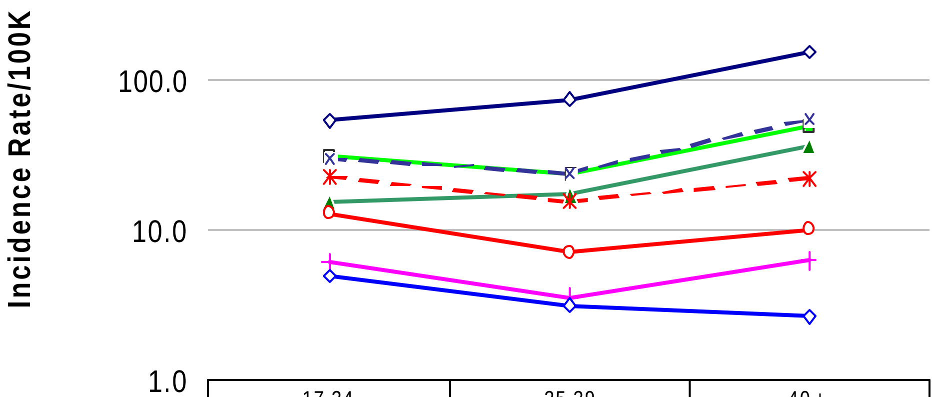


Table 7. Number and percent of occupational injuries in each age group, by civilian vs military

Age Category	Civilian	Military	Total
18-24	585 23.1%	1,953 77.0%	2,538 100.0%
25-39	3,258 61.7%	2,021 38.3%	5,279 100.0%
40+	**6,690** **97.6%**	**161** **2.4%**	**6,851** **100.0%**
Total	10,533 71.8%	4,135 28.2%	14,668 100.0%

Figure 18. Incidence rate, major types of occupational injuries by age category, military & civilian



	17-24	25-39	40 +
strain	52.7	73.8	154.4
fracture	31.3	23.9	49.0
sprain	15.3	16.9	36.6
contusion	29.9	23.8	54.6
laceration	22.7	15.2	22.0
burn	13.0	7.0	10.0
abrasion	6.1	3.5	6.2
concussion	4.9	3.1	2.6

age category

Finding the true rate of occupational injuries is challenging enough overall, but particularly so in the military. Civilian payroll information has been used by DoD to find a truer denominator or exposure, but no such payroll accounting exists for the military. We used person-year contribution without any exception: every airman contributed fully to the denominator, i.e., one person = 1 year of occupational exposure time. In reality, we don't know the hours worked by airmen.

A bigger problem when comparing military and civilian is the disparity in exposure to workplace hazards in the so-called dirty shops that have largely been civilianized over the years. A valid comparison would require a complex job exposure matrix on which rates could be adjusted for differences in workplace hazards (exposures) between various occupational categories, assuming that one could even reliably quantify or index occupational safety hazards. Even with such an exposure matrix, we could only assume the proportion of time that airmen spend in hazardous areas. Assumptions regarding exposure-time by rank and occupational groupings would always be questioned as to their validity.

Chapter 4. Military-only Analysis

The burden of reported lost workdays in Air Force military personnel was substantial, accounting for 67% (171,115/254,507) of the total force (combined military and civilian) lost workdays. This difference was mainly due to the military's inclusion of off-duty personal motor vehicle (PMV) and sports and recreation mishaps, not reportable in the civilian employee population. When PMV and off-duty (almost entirely sports and recreation) mishaps are excluded from analysis the lost day proportions change dramatically. Civilian totals are virtually unchanged (losing 1% from 83,392 to 82,562 lost workdays), while military totals sharply drop (losing 85% from 117,115 to 24,861). All the following tables reflect this difference in reporting, with recreational activities higher in the military rankings, and occupationally related activities higher in the overall rankings.

Activities Associated with Lost Workdays

Table 8 lists the top 10 activity generators of lost workdays along with the number of injuries reported for that activity, the average (mean) and median numbers of days lost per injury, and the percent of the activities' injuries that occurred on base. Recent statistical trends are also described. The listing represents 10 of the 128 possible injury-generating activities and 66% (14,726/22,249) of all LWI's that occurred during the period. The activities were unevenly split on where the injuries were most likely to occur; 52% of all military LWIs occurred off-base.

The *operating and riding in or on vehicles or equipment* category is, for the military, related far more to vehicles than for equipment, as evidenced by an on-base fraction of only 13 percent. This category shows that the youthful military reflects societal trends in which motor vehicle mishaps are a leading cause of injury in the younger driver-age groups.

Basketball, softball and football are notable since they are specific injuries that occur predominately on-base, and therefore may be targeted for prevention initiatives. These data do not suggest that these three activities are the most inherently risky, since accurate denominators of participation are not available. Rather, these numbers probably reflect high participation due to widespread intramural programs.

Table 8. Total lost workdays, total reported injuries, and average days lost per injury, military only, top 10 external cause or specific categories only*, by total lost workdays

Rank	Activity	Total lost wkdays	Total injuries reported	Lost wkdays per injury: Mean / Median	On base percent	Recent trend
1	Operating vehicles or equipment	46,818	4,390	10.7 / 3	13.0%	3-yr plateau
2	Slips, trips, & falls (STF)[†]	14,554	2,032	7.2 / 3	61.1%	2-yr surge
3	Riding in or on vehicles or equip	13,023	1,147	11.4 / 4	15.9%	Surge in '01
4	Playing basketball	12,520	2,165	5.8 / 2	78.2%	Steady
5	Climb/descend stairs or ladder	6,902	965	7.2 / 3	59.1%	Steady
6	Playing softball	6,843	1,171	5.8 / 3	70.6%	2-yr plateau
7	Trail riding--dirt bike/ATV/Quad	5,563	454	12.3 / 7	7.7%	Surge in '02
8	Playing flag football	5,406	939	5.8 / 3	74.4%	Erratic
9	Struck/struck by object [‡]	5,208	932	5.6 / 2	73.0%	Surge in '02
10	Lifting/carrying (non-STF)	3,386	1,231	2.8 / 2	72.1%	Declining

* Excludes categories such as "standing" which convey only incidental activities

[†] Numerous activities were associated with this category, but specific well-defined activities (e.g., STF due to playing basketball or softball, or climbing a ladder or stairs) were included in those more specific categories, not included under this general STF category. Activity breakdown: general walking (n = 2,363); stepping up or down from/to uneven surfaces such as curbs (n = 380); entering/exiting buildings or vehicles (n = 368); carrying items (n = 254); while handling or carrying items or equipment (n = 155); running--not associated with sports, jogging, or PT (n = 138); and dozens of other activities

[‡] Does not include persons being stuck by objects that they dropped; being struck by a dropped object is categorized here as lift/carry/handle; also does not include being hit by a motor vehicle (pedestrian injuries are included in lower frequency categories not included in this table)

Table 9 lists those activities associated with the most severe LWIs, as measured by the average number of lost workdays per injuries. Again, off-base and recreational injuries dominate the picture, only parachute activities all occurred on duty whether on or off the installation. This table is almost identical to that in the overall analysis, with the exception of the occupationally related activities, such as electrical work, dropping out.

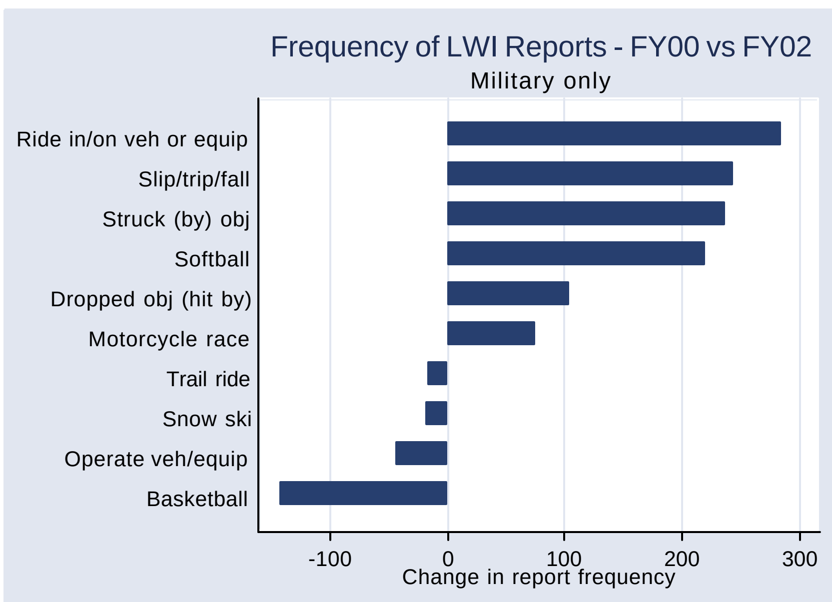
Table 9. Mean lost workdays per injury--specific categories only*

Rank	Activity (# reported injuries)	Mean Lost workdays per injury
1	Hang gliding (10)	24.4
2	Rock climbing (41)	18.2
3	Sky diving/parachute jump, off duty (52)	16.3
4	Parachute activities, military on duty (29)	15.9
5	Diving--not scuba/sky (31)	13.1
5	Trail riding, dirt bike/ATC/ATV/Quad (454)	12.3
7	Motorcycle racing (112)	12.1
8	Riding in/on (1148)	11.4
9	Snowmobiling (49)	11.2
10	Handling/shooting firearms (104)	11.1

* Activities generating at least 10 injuries in 10 years; excludes categories such as "walking" which convey only incidental activities; extremely low frequency activities excluded (e.g., sanctioned automotive racing, n = 1, 83 lost workdays; flying model aircraft, n = 3, avg 33.3 lost workdays)

Analysis of recent trends indicates that not all injury-producing activities are experiencing the same pattern shown in the overall trend charts. **Figure 19** compares the reported frequency of LWIs by the major categories--those that generate the most injuries. We chose to compare FY02 to FY00, not some earlier year due to the influence of AFSAS on mishap reporting. Of particular interest are the 2 activities that are predominantly motor vehicle related, *riding in/on vehicles or equipment* and *operating vehicles or equipment*. Both of these activities are predominantly "vehicles" in the military part of the total force. The categories are mutually exclusive, so the first category generally means "motor vehicle passenger" while the latter category is generally "motor vehicle operator". The *riding in/on* category was associated with an increase of 286 LWIs in FY02 vs FY00 while there were 44 fewer LWIs reported in the *operate vehicle/equipment* category in FY02 than in FY00. This finding may indicate that motor vehicle mishaps--fatal or not--may increasingly be involving more passengers.

Figure 19. Change in frequency by injury activity, FY02 compared to FY00



Injury Type

Fractures were the dominant type of severe injury (8 of 10 activities) as dislocations, concussions, and other injuries with high severity occurred infrequently (**Table 10**). The dominance of fractures differs from the civilian profile that was mainly soft tissue injuries (see Chapter 5). Trail riding (motorized) produced the highest proportion of fractures (60%). Softball, STF, climb/descend stairs or ladder, and snow skiing injuries produced moderately high percentages (40%-49%) of fractures. Fractures were in the top 3 profiles in each of the 10 major LWI-producing activities, with handling items/equipment producing the lowest percentage of these injuries (14%), which was still remarkable.

Strain and sprain injuries were the most common secondary factor, with strain (87%) being the leading injury in the lift-carry-handle category. Not surprisingly, these strains were almost entirely of the back. This table is almost identical to the overall analysis in both nature and percentage with only two differences. First, the percentage of fractures was much higher in slips, trips, and falls (42% vs. 27%) and climb/descend stairs or ladder (44% vs. 31%) in the military population.

Further analysis shows that two-thirds of the military STFs occurred off-duty, suggesting that those off-duty STFs produce more severe injuries. Second, hernias drop off the injury profile for lift-handle-carry in the military population. Possible explanations for this observation include the difference in average age (25 for military, 43 for civilian), and a difference in occupational duties.

Functional Areas

Table 11 lists the top functional areas generating lost workday injuries, along with corresponding ranks for the total lost workdays. This listing once again emphasizes the importance of off-duty military mishaps as they accounted for 82% of the 22,224 LWIs. Examples of functional areas not listed below are administrative functions, aerial port, missile maintenance, test and evaluation, EOD, and OSI.

Combat training-related injuries had the highest average number of lost workdays--nearly 11 days--that was about 3 days longer than off-duty military injuries. The median lost number of workdays was, however, only 3. This indicates considerable right skewing caused by a relatively few extreme values or outliers (i.e., an uncommonly high number of lost duty days) clearly seen in **Figure 20**. While the median is a more representative statistic of lost duty time for this functional area, the median also diminishes the statistical impact of catastrophic injures that occur. Preventing any reasonable fraction of combat training injuries will likely prevent some of those most severe injuries, thus conserving a larger number of duty days. Twenty percent of these injuries each generate more than 2 weeks of lost duty time while 10% produce 30 or more days of lost duty.

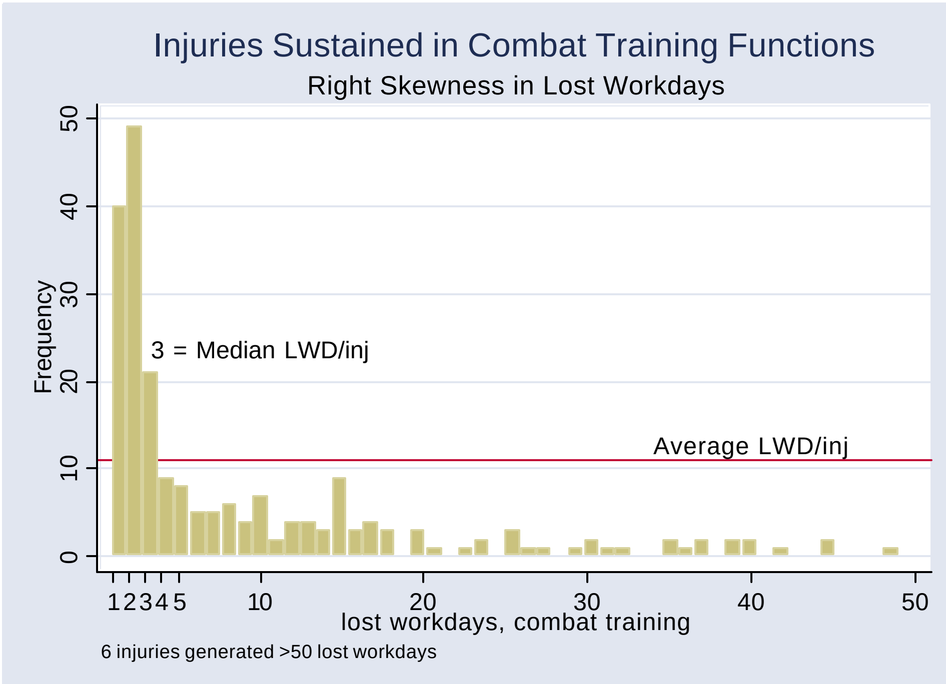
Table 10. Predominant nature of injuries associated with Top 10 total lost workday activities

		Activities' nature of injury profile		
Frequency Rank	**Activity**	**Leading**	**Secondary**	**Tertiary**
1	Operating vehicles or equipment	Fracture (31%)	Strain (29%)	Contusion (12%)
2	Slips, trips, & falls	Fracture (42%)	Strain (16%)	Sprain (13%)
3	Riding in/on vehicles or equip	Fracture (33%)	Strain (21%)	Contusion (14%)
4	Playing basketball	Sprain (37%)	Fracture (24%)	Strain (15%)
5	Climb/descend stairs or ladder	Fracture (44%)	Strain (16%)	Sprain (15%)
6	Playing softball	Fracture (44%)	Sprain (16%)	Strain (15%)
7	Trail riding--dirt bike/ATV/Quad	Fracture (60%)	Contusion (10%)	Strain (5%)
8	Playing flag football	Fracture (36%)	Sprain (19%)	Strain (15%)
9	Lift-carry-handle	Strain (87%)	Fracture (3%)	Sprain (2%)
10	Snow skiing	Fracture (47%)	Sprain (24%)	Strain (13%)

Table 11. Predominant functional areas producing lost workday injuries with lost workdays per injury as an index of severity, military only

Lost wkday inj rank	Functional Area	# Lost Workday Injuries	Lost workdays per injury
1	Military off-duty	18,250	8.0
2	Aircraft maintenance	1,289	5.1
3	Civil engineering	546	6.7
4	Security	365	7.5
5	Combat training	222	10.9
6	Operations	207	7.6
7	Communications/Computer Ops	186	6.9
8	Supply/Logistics	185	4.3
9	Transportation	170	5.6
10	Medical/health services	137	4.8

Figure 20. Frequency distribution of lost workdays associated with injuries sustained during combat training, with right-skewness indicating extreme values influencing the statistical average

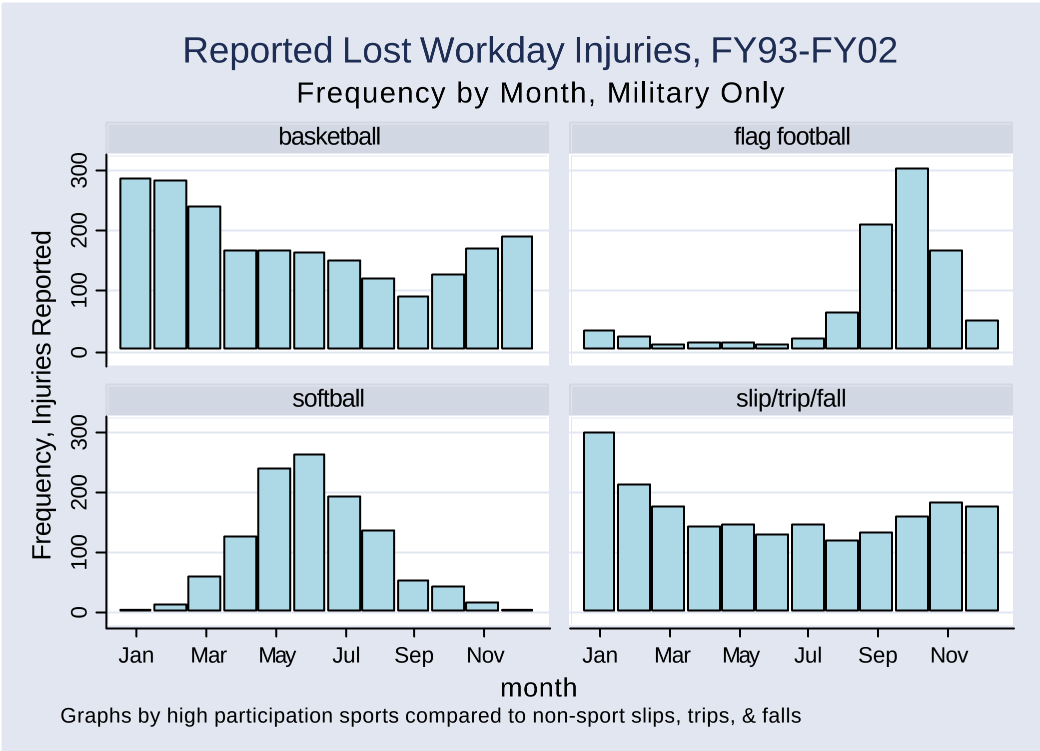


Sports and Recreation Injuries

Figure 21 shows the monthly frequency distribution of the major sports compared to non-sports STF[8]. Sports injuries followed expected patterns with regards to when those sports are most commonly played. Basketball has a more year-round schedule and injuries are still relatively frequent in off-peak warmer months. Non-sport STF frequencies follow the same seasonal pattern as basketball and are of the same magnitude. While basketball injuries most commonly occur indoors during the colder months, the STF injury spike during the winter is due to STFs on ice- and snow-covered walkways. SEPR recently completed a separate analysis on this particular type of mishap; briefing slides are available upon request.

[8] Recall that STFs occurring as a result of playing a sport are included in that particular sport, not in the non-sport STF category

Figure 21. Military LWIs by month and activity



The Air Force encourages a fit and healthy force by promoting participation in sports and recreational activities. Given this emphasis, it is appropriate that we present a separate detailed analysis of these high volume LWI generators to assess injury severity (median lost workdays per injury). As a means of comparison, we have included the high frequency STF injuries as a "control" type of injury. The analysis is based on the median number of lost workdays per injury since the above noted skewness is so prevalent. In **Figure 22** & **Figure 23** we break down the most predominant types of injuries into the 3 major sports (basketball, softball, flag football) along with STF, by age group.

Age-related patterns are prevalent in fractures and dislocations that are generally consistent with increased recovery time with increasing age (**Figure 22**). However, with softball injuries of this type, the median number of lost workdays decreases as age advances. Perhaps this indicates a decrease in the amount of energy dissipated during the injury as running speed decreases with age. This may also indicate a purposeful age-related decrease in intensity, e.g., no longer diving for balls or otherwise playing with reckless abandon.

Also noteworthy is that STF injuries of this type are apparently more severe in all age categories when compared to sports related fractures and dislocations. Most STFs result in impact with surfaces that are harder and do not absorb much of the energy dissipated during the impact, e.g., concrete sidewalks, asphalt parking lots, hard flooring, etc. STF do not include falls while climbing ladders or scaffolding, but do include injuries that occur in falling from one level to another, e.g., from a aircraft wing to the hangar floor. The “distance times mass” factor in these mishaps accounts for levels of kinetic energy for which the human body cannot safely absorb.

In soft tissue injuries such as sprains and strains, injured airmen generally lose 2 days of duty in the major sports and in STF regardless of age (**Figure 23**). However, the youngest age group generally returns to duty sooner after being injured while playing softball or football, and those 40+ are likely to take twice as long to return to duty after sustaining a flag football injury of this type. Since STF injuries in this category are no more--or sometimes less--severe than sports related injuries, the surface on which one lands seems not to be the determining factor with regards to severity (days lost). Rather, these injuries may have been events in which the level of intensity (speed or falling distance) was lower. Intrinsic individual factors (e.g., bone density and diameter, muscle mass) no doubt came into play as well. While one person may strain a ligament while sliding into third base and lose 2 duty days, another person may fracture their femur, losing a week of duty, while all other parameters of the slide are constant.

Figure 22. Median lost workday analysis: fractures and dislocations

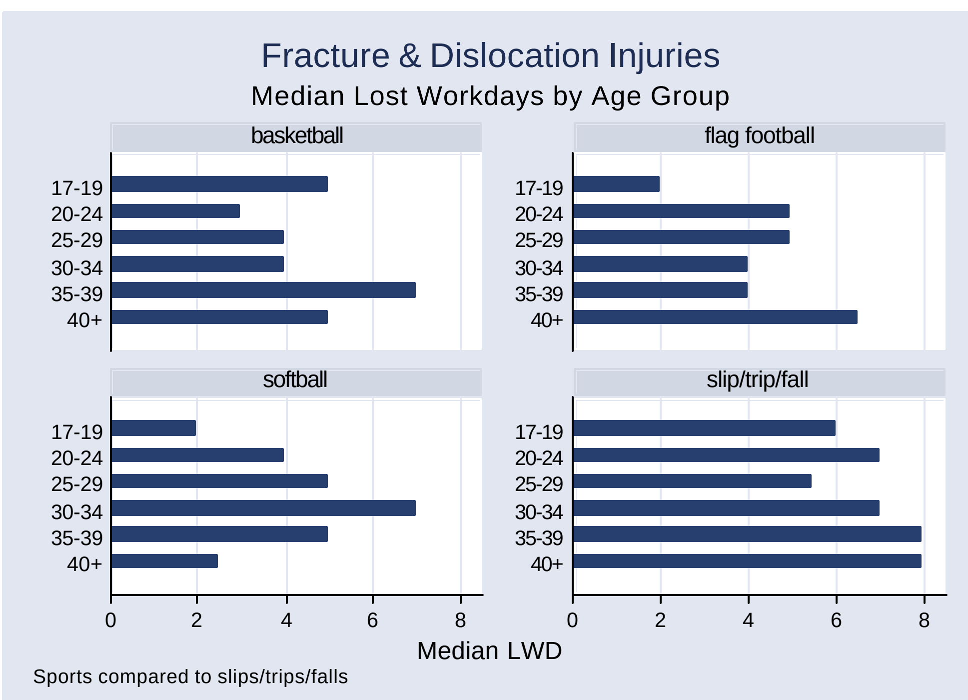
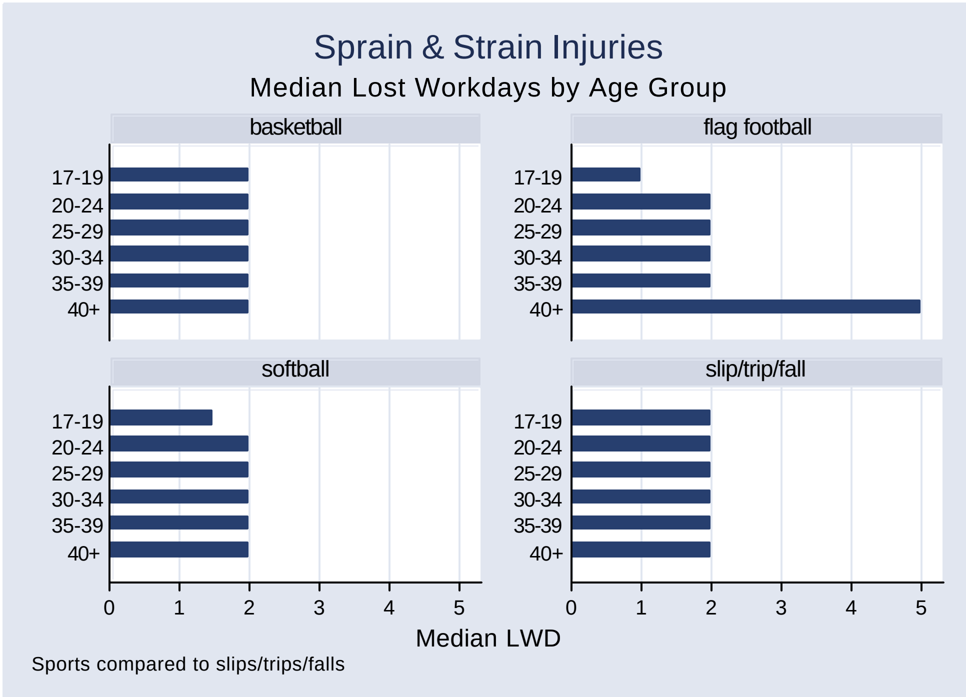


Figure 23. Median lost workday analysis: strains and sprains



As expected, we found some notable age-related trends suggesting that older airmen lose more duty days given the same type of injury and in the same sport. Also, STFs generated more lost workdays per injury than the sports did when the injury was a fracture. This was likely due in part to impact with harder surfaces. These injuries appeared to be unrelated to age.

Injury prevention initiatives could target specific sports by age groups in order to reduce the most costly injuries in terms of days lost. Besides awareness campaigns on the value of training properly for the specific sport, perhaps pre-season conditioning would help persons in all age groups, but particularly so for the older players.

Our next report will examine specific details of these and other activities that we have analyzed here. For softball injuries for example, our analysis will break the injuries down by sub-activity, e.g., sliding into bases, being hit with the ball (thrown vs batted), and other aspects of the game.

Injuries Associated with Operating or Riding In/On Vehicles or Equipment

For this more detailed analysis, we restricted the venue to off-base mishaps. Given that restriction, this activity category is overwhelmingly “vehicles” not “equipment” since the latter is more job-related and thus on-base. Almost 99% of these injuries were associated with mishaps coded in the database as private motor vehicle or government motor vehicle.

Figure 24 shows that, compared to other injury-producing activities, injuries associated with operating or riding vehicles or equipment has a stronger seasonable component. This seasonal pattern, however, is not particularly strong. We have no certain explanation for the October peak in the other off-base injury-generating activities.

The impact of these injuries on the USAF’s lost workday rate becomes obvious when comparing operating/riding injuries to injuries due to other activities on median lost duty time per injury which is a surrogate measure for injury severity (**Figure 25**). We did this analysis for dislocations and fractures in order to compare like-type injuries. Using the entire field of injuries (from concussions and fractures to bruises) would have made such a comparison an”apples-to-oranges” scenario since most of those other activities produce far fewer fractures and dislocations. Given that the type of injury was either a fracture or dislocation, the operating/riding injury was more severe than the same type of injury sustained during some other activity regardless of the age category.

Operating/riding injuries had remarkably similar median LWD across the age categories from age 20 on, and they consistently produced twice as many LWD per injury as did those injuries in the other activities. Both the frequency and severity of these injuries make this activity category an attractive target for lost workday reduction. Despite the allure of this target, however, it is not easily hit.

Figure 24. Frequency distribution of vehicle- and equipment-related injuries vs other injury-related activities by month

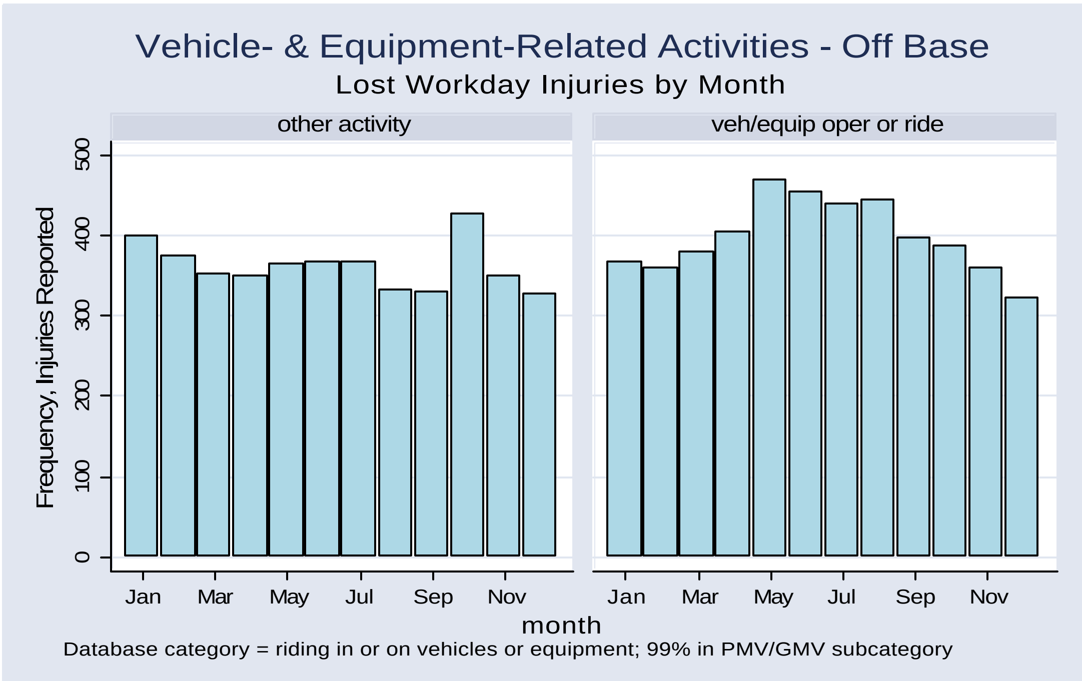
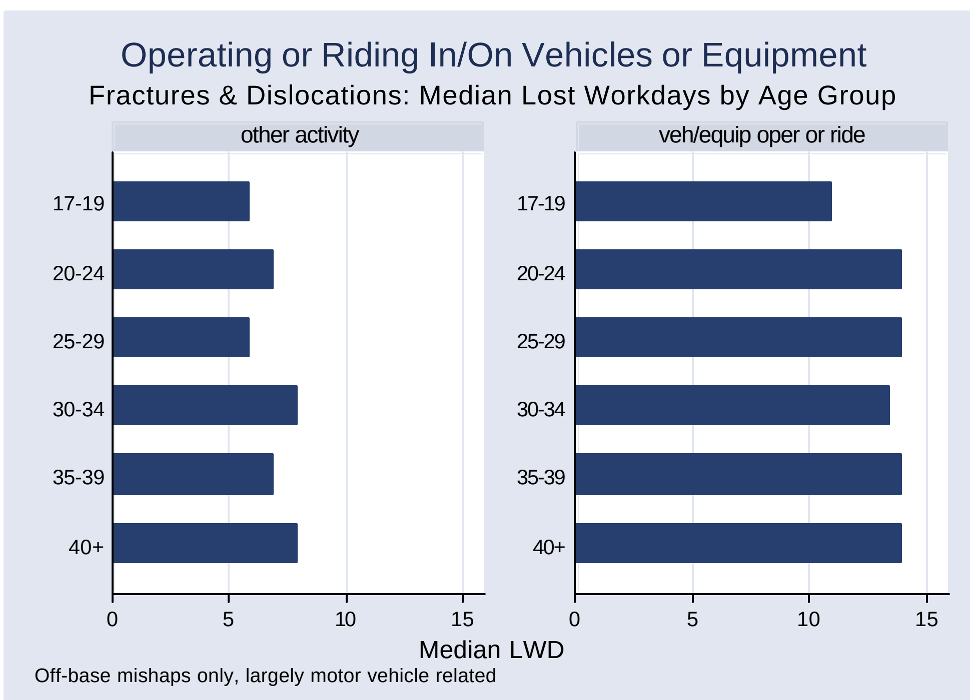


Figure 25. Median LWD comparison: operating or riding in/on vehicles or equipment vs other injury-producing activities



Chapter 5. Results: Civilian-only Analysis

Over the past 10 years (FY93-FY02) there were a total of 10,563 reported lost workday injuries among Air Force civilian employees. These reported injuries generated 83,392 lost workdays.

Activities associated with lost workdays

Table 12 lists the top 10 activity generators of civilian lost workdays along with the number of injuries reported for that activity, the average (mean) and median numbers of days lost per injury and the percent of each activity's injuries that occurred on base. Recent statistical trends are also described. The listing represents 10 of the 70 possible injury-generating activities reported for civilian workers and 87% (9,160/10,563) of all civilian LWIs that occurred during the period. All of the 60 non-listed activities totaled fewer than 100 LWIs each over the 10-year period. For civilians, the number one activity, "Slips, trips and falls (STF)", accounts for about one-third of all LWIs and total lost workdays. It is interesting to note that 65% (2,120/3,251) of the STFs were associated with general walking, entering/exiting building or vehicles and stepping up or down from/to uneven surfaces such as curbs.

Table 12. Civilian total lost workdays, total reported injuries, and average days lost per injury, top 10 specific external cause or activity categories only, sorted by total lost workdays*

Rank	Activity	Total lost wkdays	Total injuries reported	Lost wkdays per injury: Mean / Median	On base percent	Recent trend
1	Slips, trips and falls (STF) †	27,593	3,251	8.5 / 4	97.5%	Declining
2	Lifting/carrying (non-STF)	21,454	2,854	7.5 / 4	98.9%	Declining
3	Climb/descend stairs or ladders	10,469	1,083	9.7 / 4	98.5%	Declining
4	Struck or struck by object (not dropped) ‡	6,090	998	6.1 / 3	98.9%	Erratic
5	Operating vehicles or equipment	2,217	190	11.7 / 5	73.2%	Steady
6	Dropped object (hit by)	1,441	245	5.9 / 3	98.8%	Erratic
7	Handling	1,314	186	7.1 / 3	98.9%	Declining
8	Riding in/on vehicles or equip	1,056	100	10.6 / 4	78%	Erratic
9	Using hand tools	1,040	165	6.3 / 3	100%	Increasing
10	Using power equipment	683	88	7.8 / 4	100%	Steady

* Excludes categories such as "standing" which convey only incidental activities

† Numerous activities were associated with this category, but specific well-defined activities (e.g., STF due to playing basketball or softball, or climbing a ladder or stairs) were included in those more specific categories, not included under this general STF category. Activity breakdown for civilians: general walking (n = 1,619); entering/exiting buildings or

vehicles (n = 263); stepping up or down from/to uneven surfaces such as curbs (n = 238); carrying items (n = 170); while handling or carrying items or equipment (n = 88); sitting on a chair or stool (n = 87); and miscellaneous activities

‡ Does not include persons being stuck by objects that they dropped; being struck by a dropped object is categorized here as “Dropped object (hit by)”; also does not include being hit by a motor vehicle (pedestrian injuries are included in lower frequency categories not included in this table)

Table 13 lists those generally less frequent activities associated with the most severe LWIs, as measured by the average number of lost workdays per injuries. The injury types associated with, “Loading/Unloading (not Weapons)”, were a mix of vehicle/pedestrian mishaps, lacerations, chemical exposures and many other miscellaneous injuries. As expected, motor-vehicle related mishaps (as operators) generate a high number of lost workdays per injury. However, these work related vehicle mishaps are fairly low in occurrence.

Table 13. Civilian total lost workdays per injury--specific categories only*

Rank	Activity (# reported injuries)	Lost workdays per injury
1	Loading/Unloading (not Weapons) (31)	13.8
2	Operating vehicles or equipment (190)	11.7
3	Riding in/on vehicles or equip (100)	10.6
4	Connecting/Disconnecting Equipment (28)	10.5
5	Jumping up or over/from or off (26)	10.3
6	Removing (49)	10.3
7	Standing (51)	9.8
8	Climb/descend stairs or ladders (1083)	9.7
9	Weapons Loading (30)	8.8
10	Closing/Opening (38)	8.7

* Activities generating at least 20 injuries in 10 years; excludes categories such as “observing” or “inspecting” which convey only incidental activities

Table 14 shows the nature of the injuries associated with civilian mishap activities. Strains, bruises (including contusions) and lacerations were the dominant types of injury and all are closely related to the type of activity. For example, 86% of all injuries related to “Lifting/carrying (non-STF)” are muscle strains and predominantly back strains. Injuries associated with STFs, while not necessarily severe, are the expected foot, ankle, leg and knee ‘strains,’ ‘bruises’ and ‘sprains.’

Table 14. Predominant types of injuries associated with civilian top 10 total lost workday causes or activities

Frequency Rank	Activity	Activities' nature of injury profile: Leading	Secondary	Tertiary
1	Slips, trips and falls (STF)	Strain (30%)	Bruise (20%)	Sprain (20%)
2	Lifting/carrying (non-STF)	Strain (86%)	Hernia (5%)	Sprain (3%)
3	Climb/descend stairs or ladders	Strain (32%)	Sprain (21%)	Fracture (20%)
4	Struck or struck by object	Bruise (36%)	Laceration (17%)	Fracture (16%)
5	Operating vehicles or equipment	Strain (50%)	Fracture (14%)	Bruise (13%)
6	Dropped object (hit by)	Bruise (47%)	Fracture (23%)	Strain (9%)
7	Handling	Strain (26%)	Laceration (15%)	Burn, 2nd Degree (7%)
8	Riding in/on vehicles or equip	Strain (35%)	Fracture (24%)	Bruise (22%)
9	Using hand tools	Laceration (38%)	Strain (33%)	Puncture (5%)
10	Using power equipment	Laceration (41%)	Strain (16%)	Avulsion/Abrasion* (7%)

* Tie

Lost workday injuries by functional area

Table 15 lists the top functional areas generating lost workday injuries, along with corresponding ranks for the total lost workdays. For civilian employees, the 'high-three' functional areas are associated with the more industrial and service oriented civilian occupations.

Table 15. Predominant civilian functional areas producing lost workday injuries with lost workdays per injury as an index of severity

Lost wkday inj rank	Lost wokday rank	Functional Area	# Lost Workday Injuries	Mean Lost workdays per injury	Median Lost workdays per injury
1	1	Aircraft Maintenance	3,311	7.2	3
2	3	Services//MWR	2,243	7.3	3
3	2	Civil Engineering	2,085	9.0	4
4	4	Other	821	8.4	3
5	5	Supply/Logistics	513	7.5	3
6	6	Transportation	308	8.8	5
7	7	HQ/Base Command & Admin	207	8.9	4
8	8	Medical Services	184	9.7	4
9	9	Comm/Computer Operations	172	9.7	4
10	10	Personnel	159	7.4	3

Summary

This report is the first-level look at what lost workday injuries really are and where the economic and readiness losses occur. Many of the trends are favorable, yet the rate of decrease in some measures does not appear to be rapid enough to meet DoD lost workday reduction goals unless more investments in mishap prevention occur throughout the USAF. Since previous analyses have focused almost exclusively on the predominantly off-base and off-duty Class A mishaps, the distinction between on and off-duty non-fatal LWI is probably under-recognized and therefore underappreciated. Using a duty perspective is of value in illustrating the current problem of meeting the new DoD LWI goal. Since on-duty LWI are more controllable, it is appropriate to focus more on those. But, on-duty mishaps account for only 44% of all LWI, therefore, *all* on-duty mishaps could be prevented and the goal would still be unmet!

The historical downward trend of LWI rates stopped in FY00, and this may be due in part to the implementation of AFSAS. Post-AFSAS rate increases should probably be viewed as an artifact of fielding a new system that promotes mishap reporting. But any increases since then are probably "real". Overall, the Air Force's incidence of reported injuries is low: 5.9 injuries per 1,000 worker-years, with a lost workday rate equivalent to losing only 2 workers in 10,000 per year. Most rate-based incidence trends (injuries, lost workdays) are moving in the desired direction once the assumed AFSAS effect is accounted for. However, civilian and military trends are not actually tracking the same type of LWI. Civilian LWIs are almost entirely occupational in the strict sense of that term, while a full 85% of military LWIs consist of sports & recreation and PMV mishaps. Despite the generally favorable impression from the trend analysis, the raw high numbers of lost work/duty days indicate that we must do more to stop the hemorrhage of resources. Over the 10-year study period, the Air Force's mishap reporting system logged close to 33,000 LWI and over a quarter-million LWD within its military and civilian populations.

Many potential targets exist in the civilian occupational injury arena where the higher risk jobs and people are easily identified. Clearly, the civilian element with the greatest risk of occupational injury is in the wage grade sector although general schedule firemen also warrant special attention. Nearly 98% of civilian occupational injuries occur to people over age 40, thus these relatively older workers present a challenge to occupational health and safety managers. Perhaps our next analyses will be able to describe in greater detail where the problems lie.

Recreational activity is generally a virtue, as participation in these activities promotes good health and overall readiness. These activities also generate a large number of lost workdays. Our second-level look will hopefully provide more detail on prevention opportunities within the specific activities, but any injury reduction initiative in this area should target older airmen (age 35+) for special injury prevention techniques. The data indicate that age is related to either higher injury severity or to longer recovery time from those injuries. Either way, their injuries contribute more lost time per injury than do injuries in younger airmen. Thus, adding an “older airman” element to an overall sports and recreation injury reduction plan should have a noticeable effect on lost workdays.

Historically, dramatic shifts in the national mishap rates have been achieved over decades--not years. Specifically in the area of motor vehicle safety (which is appropriate for our current situation), strides have only been made through long-term engineering changes. Pursuing the goal of mishap reduction is certainly worthwhile and will return dividends. However, reaching too far too fast may produce unintended consequences such as mishap underreporting, underutilization of medical care, or a drop in morale due to discontinuation of sports and recreation opportunities. As Albert Einstein once said, "The significant problems we face cannot be solved with the same level of thinking we were at when we created them."

Appendix

Johns Hopkins University-Army Center for Health Promotion and Preventive Medicine (CHPPM) Criteria to Rank Injury Prevention/Control Program & Policy Priorities

A group of academic and military injury experts[9] met in Baltimore MD in October 2002 to help CHPPM set priorities for their injury prevention and control programs. The following set of criteria was used to derive those priorities.

CONSISTENT WITH MISSION

IMPORTANCE OF PROBLEM

- Magnitude and severity of problem (readiness and economic impact)
- High costs of problem (retraining, property and personnel)
- Size and/or vulnerability of population at risk
- Degree of concern (command influence/ public concern/high visibility)

PREVENTABILITY

- Problem is preventable or can be reengineered
- Modifiable risk factors
- Proven prevention strategies exist
- Identifiable cause of injuries (more problematic with musculoskeletal problems or overuse injuries-- harder to capture & document events)

FEASIBILITY

- Infrastructure(medical or safety) exists to support prevention efforts
- Adequacy of resources (money for implementation.)
- Influence on off base/off duty mishaps (feasible for organization to implement intervention?)
- Is activity required or mission essential?
- Politically/culturally/socially acceptable
- Accountability/responsibility exists or is possible

EVALUATION

- Capability to evaluate prevention efforts (metric possible)
- Benefits outweigh costs of implementation

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[9] Lt Col Bruce Copley from the AF Safety Center was a member of that group