



# A Structured Review of the Literature to Identify Fall Prevention Strategies

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Today I will share results of a systematic (or structured) review of the literature to identify work-related fall prevention strategies.

Photos:

1. U.S. Army soldiers from 1st Battalion, 320th Field Artillery Regiment, 2nd Brigade Combat Team, 101st Airborne Division connect lifting slings between M-119A2 lightweight towed howitzers and UH-60 Black Hawk helicopters from 5th Battalion, 101st Combat Aviation Brigade, 101st Airborne Division during training exercises at Fort Campbell, Ky., on June 9, 2009. The process is complicated by flying debris kicked up by rotor wash. DoD photo by Larry Noller, U.S. Army. (Released): 090609-A-4125N-395 (<http://dodimagery.afis.osd.mil/products.html>)
2. U.S. Army Sgt. Willie Fout and other Soldiers from 3rd Brigade Combat Team, 4th Infantry Division celebrate Christmas with a flag football game at Forward Operating Base War Eagle in Baghdad, Iraq, Dec. 25, 2008. (U.S. Army photo by Sgt. Edwin M. Bridges/Released): 081225-A-1924B-100: (<http://dodimagery.afis.osd.mil/products.html>)



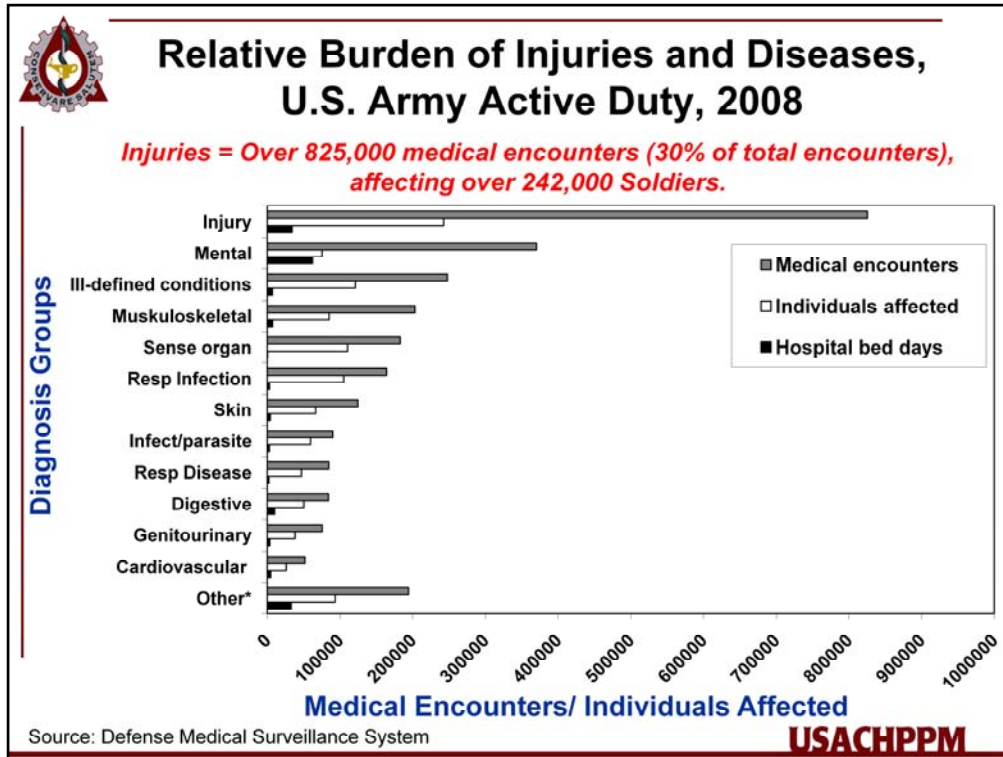
## **USACHPPM Injury Prevention Program Mission**

Enhance the combat readiness and health of soldiers by preventing injuries.

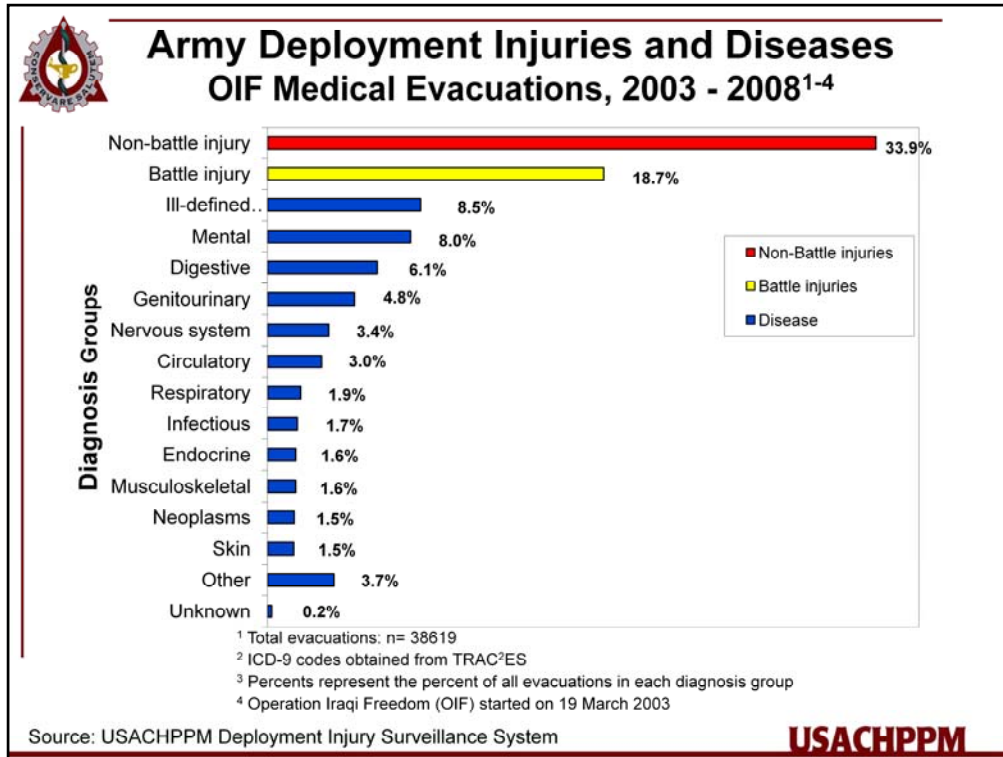
Reduce injury rates Army-wide through a systematic program that guides and supports Army and Command prevention efforts through routine **surveillance, field investigations, evidence-based recommendations, rigorous program and policy evaluation, and collaboration.**

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The USACHPPM Injury Prevention Program has the same goal as Safety – to prevent injuries. As part of the Army’s public health command, the ‘tools’ we use to do this are the following public health tools: surveillance, field investigations, evidence-based recommendations, program and policy evaluations, and collaboration.



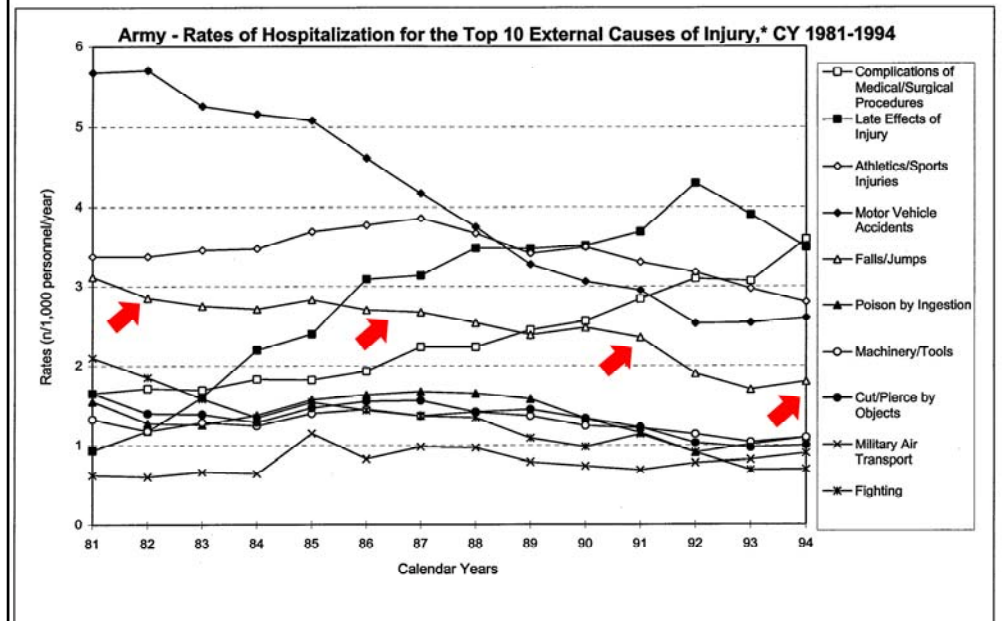
What our surveillance data tell us: In 2008, compared to all other medical conditions, injuries resulted in the greatest number of medical encounters (over 825,000) - more than twice as many encounters as the second leading cause. Compared to all other medical conditions, injuries affected the most Soldiers - over 240,000. Looking at hospital bed days, bed days due to injury (n=40,276) are only exceeded by mental disorders (n=62,326) in 2008.



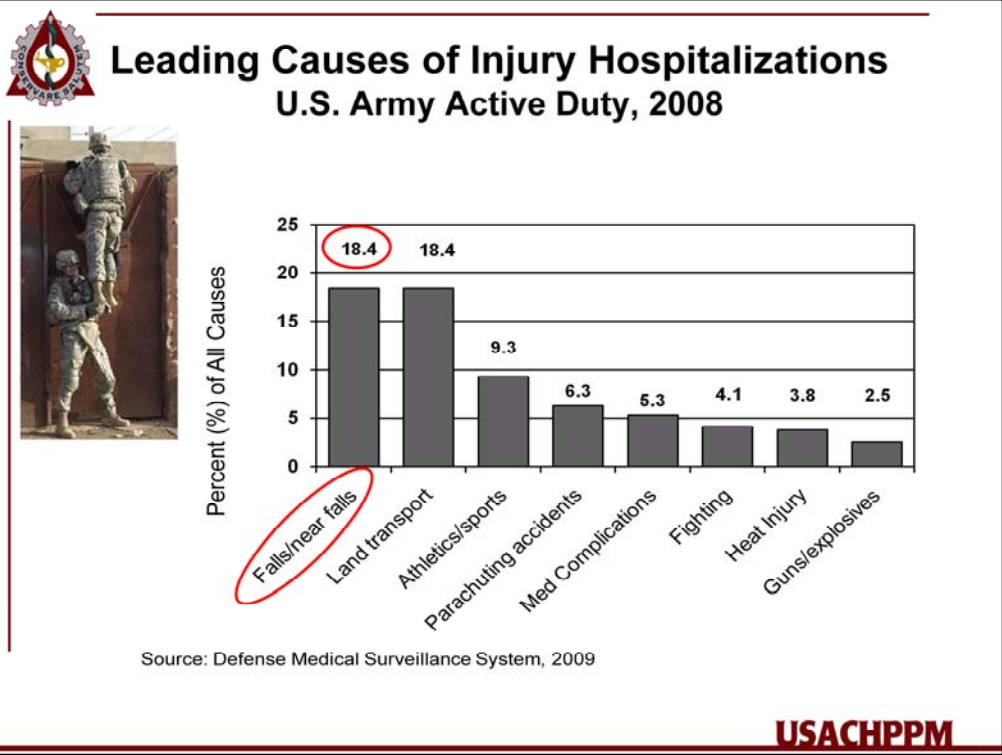
We see a similar trend for deployment-related injuries. This slide shows the frequency of injuries and diseases for Soldiers medically evacuated from OIF. From 2003-2008, non-battle injuries accounted for 34% of medical evacuations and battle injuries accounted for 19% - a total of 53% of air medical evacuations were due to injury.



## Historic data: Falls in the U.S. Army



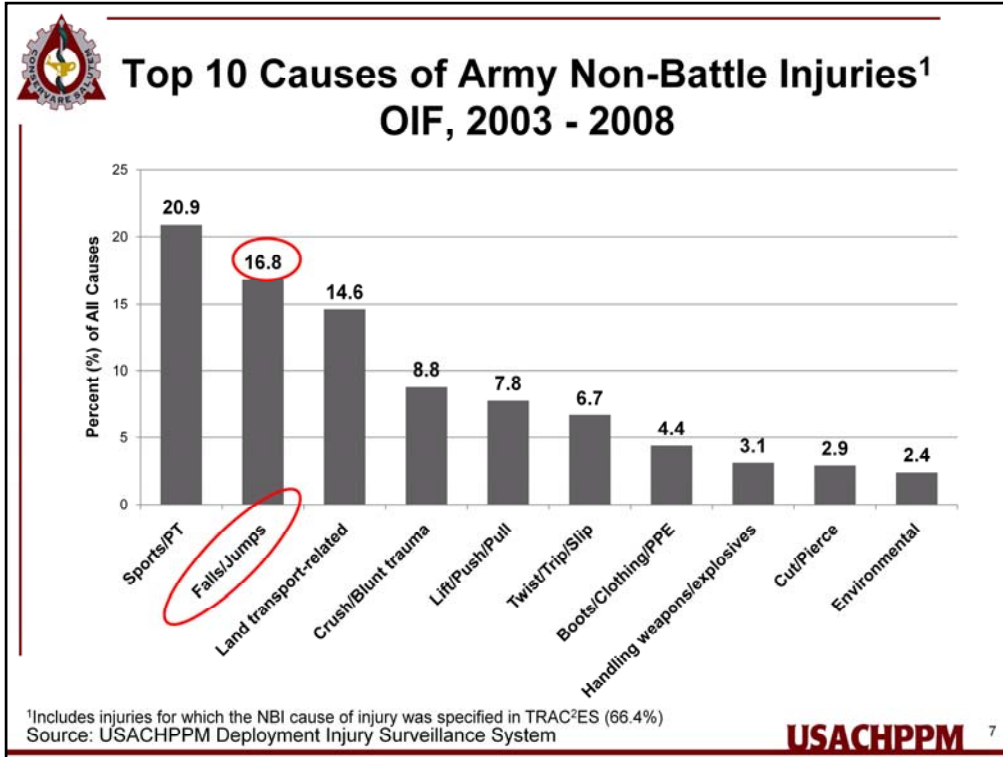
Data from the Atlas of Injuries in the US Armed Forces (*Mil Med* v164, issue 8) indicate that falls have historically been among the top five causes of injury hospitalizations for US Army personnel.



This remains true today. In 2008, falls were tied for land transport as the leading cause of injury hospitalizations.

Photo:

U.S. Army 1st Sgt. Shane Chapman from 1st Battalion, 8th Infantry Regiment, 3rd Brigade, 4th Infantry Division, hoists up Sgt. Stepankiw (same unit) to look over a door and look for possible threats in the town of Al Sinaa, Iraq, on April 1, 2008. The Unit conducts a Cordon and Search of the area for Improvised Explosive Devices, and weapon caches. (U.S. Army photo by Pfc. Sarah De Boise) (Released): 080401-A-1969D-061: (<http://dodimagery.afis.osd.mil/products.html>)



In the deployment environment, falls are also an issue, accounting for 16.8% of all NBI in OIF from 2003-2008...



...and 17.9% of all NBI in OEF from 2001-2008.





## The Public Health Approach to Fall Prevention

### Five Key Public Health Questions

1. Is there a problem and how big is it?
2. What causes the problem?
3. What works to prevent the problem?
4. Who needs to know and do what?
5. How effective is what we have done?

### Five Steps of the Public Health Approach

1. Surveillance
2. Research & field investigations
3. Intervention trials & **systematic reviews**
4. Program & policy implementation
5. Public health evaluations & monitoring

#### Resembles the Risk Management Approach:

1. Identify hazards
2. Assess hazards
3. Develop controls & make decisions
4. Implement controls
5. Supervise and evaluate

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We attack this large and complex problem using the Public Health Approach. This approach is designed to address the 5 key public health questions seen on left of this slide. Corresponding public health activities are shown on the right.

Systematic reviews, like the one I'll discuss today, are used to identify evidence-based prevention strategies that can be used to prevent the problem.

The Public Health Approach mirrors the Risk Management Approach, the steps of which are very similar.



## ***What is a structured (systematic) review?***

- A scientific investigation of the literature on a specific topic
- Includes:
  - A focused study question
  - A specific search strategy
    - Specified databases
    - Inclusion/exclusion criteria
  - Specific information abstracted from each article
  - Quality assessment
  - Quantitative summary

***Part of an evidence-based decision-making process***

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Systematic, or structured, reviews were first used in clinical medicine to evaluate the effectiveness of medical practices. This process is now being used to identify and evaluate the evidence for what works to prevent injuries. In particular, you may have heard of the U.S. Preventive Services Task Force, an independent panel of experts in primary care and prevention that systematically reviews the evidence of effectiveness and develops recommendations for clinical preventive services.

Systematic reviews have specific characteristics (listed here), which are explained in the following slides.

Such reviews are part of an evidence-based decision-making process. While we often have to go with existing, unevaluated strategies, identifying evidence-based prevention strategies is important, as there have been strategies that, when scientifically tested, were discovered not to work (e.g., back braces, stretching before exercise) or even cause harm (e.g., over-diagnosis & over-treatment due to prostate cancer screening – a new finding published in JAMA that is resulting in changes in the screening recommendations made by the American Cancer Society).



## **Purposes of this systematic review**

1. Identify existing off-the-shelf interventions for the prevention of work-related falls
2. Identify risk factors for falls among working-age adults
3. Make recommendations for:
  - interventions to pursue
  - research to fill knowledge gaps

***Final product:***  
**Report to the Military Training Task Force of the  
Defense Safety Oversight Council**

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The purposes of this systematic review were to...(#1-3)

This resulted in a final report to the Defense Safety Oversight Council, which provided the funding for this project.



## Methods

- Literature databases searched for:
  - Articles in English
  - Published 1980-2008
  - Investigated adult populations (excluding geriatric and hospital populations)
- Keywords: “intervention,” “primary prevention,” “work-related,” “slips, trips and falls,” and “ages 15-64”
- Databases searched: MEDLINE, PubMed, EMBase, NIOSHTIC, CINAHL, NTIS, DTIC, PsycINFO, Compendex, Google Scholar

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The search strategy focused on articles written in English, published between 1980-2008, and studies on adult populations. Keywords used are shown here. Since studies of occupational injuries cross various disciplines, a variety of databases were searched: biomedical (MEDLINE, Pubmed, EMBase, etc), occupational health (NIOSHTIC), engineering (Compendex), psychosocial sciences (PsycINFO) and collections of government reports (NTIS, DTIC).



## Inclusion/exclusion criteria

- Included:
  - Articles with injury outcome(s)
  - Articles with non-injury outcome(s)
  - Reviews of injury research
- Excluded:
  - Articles on a different topic
  - Other publication types (e.g., editorials, letters, opinion papers, educational articles)

This review included articles with injury outcomes (such as a fall-related injury), articles with non-injury outcomes (such as behavior change), and reviews of injury research. The review excluded articles that were on a different topic (but were picked up by the search criteria for some reason) and other publications types such as editorials, letters, opinion papers, and educational articles.



## **Methods - *Continued***

- Articles/documents meeting the search parameters identified & saved in EndNote®
- Abstracts reviewed by 2 scientists to determine study type
- Full-text articles obtained & reviewed for intervention & analytic epidemiology studies
- Quality review of intervention & analytic epidemiology studies conducted by 3 public health scientists

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All articles were organized in Endnote (reference management software), abstracts were reviewed by 2 scientists to determine study type, full text articles were obtained for the intervention & analytic epidemiology (risk factor) studies (the focus of this review), and the quality of these articles was assessed by 3 public health scientists.



## Example Quality Scoring Form

Author/Year/Title of Intervention Study:	
Date of Review:	Name of Reviewer:
<b>Problem and Sample</b>	
1. Is there a clear statement of research question or hypothesis? If yes, score 1.	Score
2. Is there a source of subjects or sample described (e.g., inclusion criteria listed)? If yes, score 1.	
3. Is there a clear description of intervention? If yes, score 1.	
<b>Study Design and Methodology</b>	
4. Is it a randomized controlled trial? If yes, score 2.	
5. Is it an observational study with data on relevant confounders? If yes, score 1.	
6. Is there collected data on important covariates used in an analysis? If yes, score 1.	
<b>Data Presentation and Statistical Analysis</b>	
7. Are statistical methods clearly described? If yes, score 1.	
8. Are confidence intervals or P-values used? If yes, score 1.	
9. Are multivariate methods in analysis (e.g., regression) used? If yes, score 1.	
10. TOTAL SCORE – Maximum score possible is 10 (transfer total to the Classification Matrix)	

\*Adapted from the Joint Services Physical Training & Injury Prevention Work Group

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Quality scores were based on satisfying certain criteria as determined by the Quality Scoring Form developed and used by the Joint Services Physical Training and Injury Prevention Work Group, which conducted a systematic review of the literature to identify physical training-related interventions (recommendations posted at <http://chppm-www.apgea.army.mil/ptipt/intervention.aspx>). (See questions/criteria #1-9 on slide)



## Results

- Identified scientific literature relating to work-related fall injuries from search of 10 databases
  - 2,228 hits originally identified
  - 522 were included after a review of the title and abstracts
  - Three additional articles identified by reviews of reference lists in selected articles
  - Most hits in PubMed (567), DTIC identified least (16)

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The search identified over 2200 articles; 522 met the inclusion criteria. Three additional articles were identified through review of article reference lists. Pubmed provided the most articles, while the Defense Technical Information Center (DTIC) contributed the least.





## Results

Distribution of Article Type		
Article Type	Total References	Percent of All References
Case Series/Case Reports	194	37%
Descriptive Epidemiology	34	6%
Analytical Epidemiology	21*	4%
Intervention	7*	1%
Reviews of Injury Research	19	4%
Non-Injury Original Research	119	23%
Research on a Different Topic	41	8%
Non-Research Article	49	9%
Other/Unable to Determine/No abstract	41	8%
Total References Categorized	525	100%

\*Full text articles reviewed & assessed for quality

Note: No studies of military populations were identified

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The greatest proportion of articles identified in the literature were case reports (37%) or non-injury research (23%). We found very few of the article types we were most interested in – analytic epidemiology (21) and intervention studies (7).



## Analytic Epidemiology Summary Of Findings

<u>Risk Factor</u>	<u>Number of Studies</u>
• Age	13
• Medical Issues/medicines (multiple risk factors)	10
• Occupational/Environmental Characteristics (multiple risk factors)	8
• Weight/BMI	6
• Gender	5
• Alcohol consumption	5
• Education	5
• Smoking	3
• Marital/Living Status	3

**Overall mean quality score: 8.3 (range: 4.3-9.3)**

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First I'll review what was found when reviewing the analytic epidemiology studies.

This slide shows the risk factors that were evaluated in the analytic epi studies. The risk factor that was most commonly assessed was age, followed by medical issues/medicines, and occupational/environmental characteristics. Overall, the quality of these studies was rated 8.3 out of a possible 10 points.



## Analytic Epidemiology Summary Of Findings - *Continued*

<u>Risk Factor</u>	<u>Upper Limit of Relative Risk*</u>
• Alcohol consumption (3+ drinks, 6 hours before fall)	12.9
• Psychotropic medications (benzodiazepine use as sedative)	10.8
• Job experience (union <2 years)	2.1
• Weight/BMI (BMI 30-35, obese)	2.0

\* Risk of fall, as compared to reference group

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This slide summarizes risk factors of potential significance to the military.

A study that looked at alcohol use and fall-related injuries occurring at home among working-age adults found that, in a multivariate model controlling for other risk factors, consumption of 3 or more drinks 6 hours prior to the fall resulted in a 12.9 times greater risk of sustaining a moderate to severe fall-related injury, compared to persons who reported no alcohol use.

A study of benzodiazepine (BZD) use found that persons age 20-59 who used BZD as a sedative were 10.8 times more likely to be hospitalized for a fall-related injury compared to persons age 20-59 who were not using BZD.

While other studies looking at duration of employment found no relationship with risk of falls, a study looking at time in a union found that carpenters with less than 2 years in the union had a 2.1 times greater odds of a fall resulting in lost-time compared to those with more than 10 years experience. This has been seen in other work-related falls studies; fall risk tends to be higher among younger workers, possibly due to inexperience or to the types of tasks they perform.

An evaluation of the effect of weight or body mass index (BMI) on fall risk indicated that persons who were obese (BMI 30-35) had twice the odds of a fall resulting in 8 or more days of sick leave compared to persons of 'normal' (BMI<25) weight. This association was seen in other studies as well.



## Analytical Epidemiology Limitations

- Interpretation was problematic:
  - Inconsistent study designs, evaluation of risk factors, & definitions of risk factors
  - Varied outcomes (e.g., all falls, falls from same level or elevation, falls resulting in fracture)
  - Too few subjects
  - Not similar to military populations

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There were some limitations of interpreting these studies, as listed here.



## Intervention Summary Of Findings

- Seven studies identified
- Overall mean quality score: 6.4 (range: 3.0-8.0)
- Types of interventions:
  - Pre- and post-regulation changes (3)
  - Fall prevention organizational intervention(1)
  - Fall prevention education (3)

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Looking at the intervention studies...

A total of 7 were identified. The overall quality score was lower than the analytic epidemiology studies (average of 6.4 out of possible 10 points). There were 3 studies that looked at pre/post regulation effects, 1 that looked at an organizational intervention to reduce fall-related injuries, and 3 that examined educational campaigns to reduce falls. The first 4 studies were completed in US worker populations; the educational campaigns were conducted in other countries.



## Intervention Summary of Findings Details

Findings before & after implementation of  
Washington State vertical falls standard (Nelson  
et al., 1997; Lipscomb et al., 2003)

- Preceded OSHA Fall Protection standard (1995)
- Study 1: Employers cited for fall protection violation were 2.3 times more likely than non-inspected employers to experience reduction in injury claim rates ( $p < 0.001$ )
- Study 2: 20% reduction in rate of falls from elevation after standard instituted; pattern sustained for 3 years later

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Two of the pre/post policy implementation studies looked at fall injury rates before/after implementation of the Washington State vertical falls standard, which preceded the OSHA Fall Protection standard of 1995.

The first study (Nelson) found that employers who were cited for a fall protection violation were 2.3 times more likely than non-inspected employers to experience a reduction in injury claim rates.

The second study (Lipscomb) used a different dataset to evaluate the effect of the Washington State standard and found a 20% reduction in the rate of falls from elevation after the standard was instituted. They had data for a longer time period, and were also able to show that this pattern was sustained for 3 years after implementation of the standard.

Both studies suggest that occupational standards and enforcement of these standards can reduce falls and/or fall-related injuries among US workers.



## Intervention Summary of Findings Details - *Continued*

Effect of OSHA construction standard on U.S. construction industry fatal falls (Derr et al., 2001)

- Overall decrease in construction industry fatal fall rates reported to OSHA from 1990-1999
  - Consistent with overall downward trends of occupational fatalities
  - Varied by occupation, union/non-union, gender
- Inconclusive: Could not attribute decline to standard (no control group, no measure of confounding factors)

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A study of the effect of the OSHA fall protection standard evaluated construction industry fatal fall rates from 1990-1999. The trend was consistent with the overall downward trend of occupational fatalities. Since comparison groups or measurements of confounders were not available, the study was inconclusive (could not attribute the decline in fatal falls to implementation of the OSHA falls standard).



## Intervention Summary of Findings Details - *Continued*

### Pilot study of fall prevention organizational intervention (Becker et al., 2001)

- 10 intervention, 6 control companies
- 'Third party' (university) provided:
  - Fall prevention training
  - Un-announced quarterly audits
- Company agreed to:
  - Designate company & site 'fall prevention competent persons'
  - Daily inspections by site supervisor; weekly by company
  - Jobsite labor/management fall prevention committee
- Incentives:
  - 'Fall Safe contractor' designation
  - Perceived: lower workers' comp, positive public relations
- Injury outcome not measured; Showed improved program audit scores, marginal improvement on hazard control scores

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The next study evaluated the effects of a program put in place among construction contractors in West Virginia. The West Virginia University Safety & Health Extension provided fall prevention training (8 hours for supervisors, 2 hours for workers) and unannounced audits of the fall prevention program and hazard controls. The participating companies agreed to designate company & site 'fall prevention competent persons', have daily inspections by site supervisors and weekly inspections by company representatives, and hold meetings of jobsite-specific labor/management fall prevention committees. The incentives included that the contractor was designated a 'Fall Safe Contractor'. Perceived benefits included lower workers' compensation claims, positive public relations, and increased market share due to the positive image. The effect on injuries was not measured. However, audits showed that the programs were in place (had improved program audit scores), but that there was no improvement in the use of fall protection (hazard controls) at the jobsites. There was no follow-up study to this pilot study, which suggests that this intensive program was discontinued.





## Intervention Summary of Findings Details - *Continued*

### Community-based educational program (Kronhed, 2005)

- Intervention and control communities, Sweden
  - Health education – diet, physical activity, smoking, environmental risk factors
  - Provided to persons age 40+
- Assessed fracture rates
  - No change in overall fracture rates
  - Decreases in forearm fractures among women
  - Slight decreases for forearm among men, trochanteric hip fractures in men and women

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Moving on to educational interventions.

This study reported results of a community-based osteoporosis and fall prevention program in which persons age 40 and over were provided a variety of health education materials through public seminars, the local press, and cable television. A random sample of community members were selected to participate in baseline bone mass measurements. They evaluated the success of the educational campaign using population-based fracture rates. They found no change in overall fracture rates, but decreases in forearm fractures among women (10 years after the program) and downward trends in forearm fractures among men and trochanteric hip fractures among both men & women, compared to the control community. Suggests that this community-based intervention program reduced forearm & trochanteric hip fractures over the long-term.



## Intervention Summary of Findings Details - *Continued*

### Worksite poster campaign (Saarela, 1989)

- Shipyard in Finland, scaffold use
- Posters displayed, pamphlets with details distributed to supervisors
- Increase in worker knowledge of hazards & preventive measures
- No change in accident rates

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A worksite poster campaign in a shipyard in Finland used posters and pamphlets with fall prevention details to increase awareness and educate supervisors and shipyard workers of fall hazards related to scaffold use. They found an increase in worker knowledge of fall hazards and preventive measures, but no change in accident rates as a result of the campaign.



## Intervention Summary of Findings Details - *Continued*

Behavior-based safety management motivation efforts (Lingard & Rowlinson, 1997)

- 7 construction sites, Hong Kong
- Goal-setting meetings showing good & bad practices related to scaffolding, heights
- No significant improvements in practices

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Finally, the third educational intervention introduced behavior-based safety management to 7 construction sites in Hong Kong. Goal-setting meetings were used to demonstrate good & bad practices related to scaffolding and heights. Unfortunately, the program showed no significant improvements in fall prevention practices. Failure was attributed to lack of commitment by management to the program.



## Conclusions

- Risk factors of potential interest to the military include: alcohol consumption, psychotropic medication use, weight/BMI, & job experience
- Enforcement of regulations provided some evidence of effectiveness
- Knowledge “*void*” exists, rather than knowledge gaps

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In conclusion...(see slide)



## Recommended 'Next Steps' for Military Fall Prevention

1. **Literature reviews** to identify additional intervention concepts (e.g., footwear, industry-specific strategies).
2. **Descriptive epidemiology** using safety reports to identify military modifiable risk factors and causes.
3. **Analytic epidemiology** in military populations.
4. **Program evaluations** of existing interventions for effectiveness and the potential for wider implementation.
5. **Research planning** using information gained from this review to fill identified knowledge gaps.
6. **Intervention trials** to implement and rigorously evaluate new interventions.

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Specific recommendations include:

Literature reviews to identify additional interventions not identified by this search.

Epidemiologic studies to understand causes and risk factors in military populations.

Program evaluations of existing, unevaluated interventions.

Research planning that uses this information on 'gaps' in our knowledge about evidence-based fall prevention to design and conduct much-needed intervention trials to evaluate new interventions.