



Military Injuries: A Review of Public Health Surveillance and Epidemiology

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Mission: The Defense Health Agency supports our Nation by improving health and building readiness – making extraordinary experiences ordinary and exceptional outcomes routine.



Vision: Unrelenting pursuit of excellence as we care for our joint force and those we are privileged to serve. Anytime, Anywhere—Always.



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DHA Public Health Goals

Protect the Force

People living and working on DOD installations and deployed around the world are protected from threats with evidence-based prevention strategies.

Promote Health

Advanced health literacy and improved health equity create the conditions for lifelong healthy behaviors and enhance medical readiness for the Joint Force and wellness for all.

Ready to Respond

The DOD is postured to face emerging threats with an adaptive and resilient ally practicing modernized public health.



Public Health Approach to Injury 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 and field investigations
3. Intervention trials and systematic reviews
4. Program and policy implementation
5. Program evaluations and monitoring

Resembles the Risk Management Approach:

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

Sources:

Jones BH, VD Hauschild, and M Canham-Chervak. 2018. *J Med Sci Sport* 21(112):1139-46.

Jones BH, DM Perrotta, M Canham-Chervak et al. 2000. *Am J Prev Med* 18(3S):71-84.



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How big is the problem?

Lessons from Military Injury Surveillance

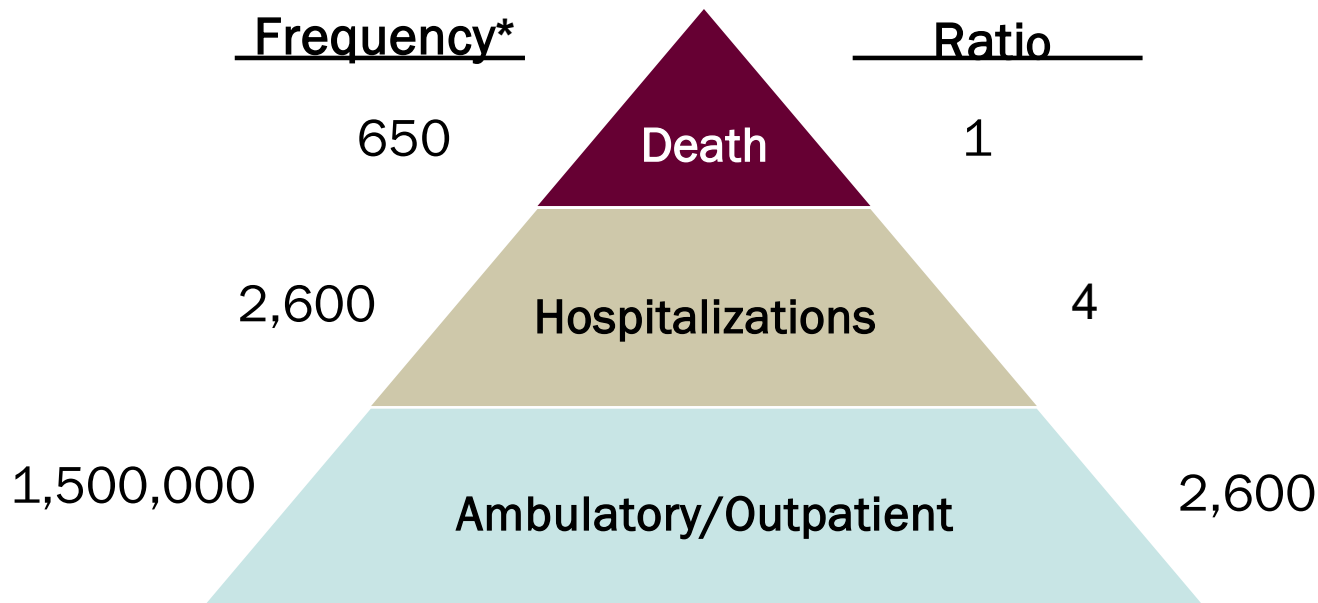


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Injury Pyramid

U.S. All Services Active Duty, 2021



*Frequencies are rounded and represent incident injury visits

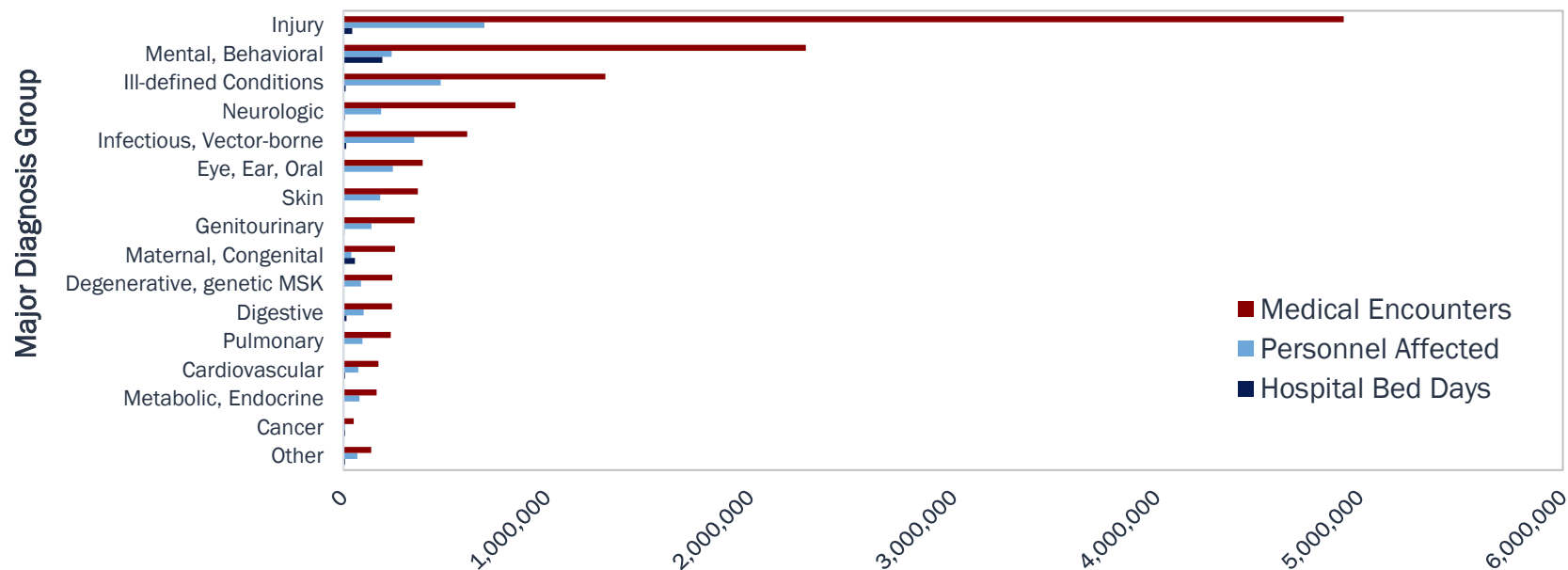


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Relative Burden of Illnesses and Injuries

U.S. *All Services Active Duty*, 2021



Notes: *MSK = damage to tissue(s) of the musculoskeletal system (i.e., bone, cartilage, muscle, tendon, fascia, joint, ligament, bursa, or synovium)

Diagnosis group “Other” includes adverse effects of drugs, blood disorders, and other neoplasms (not cancer).



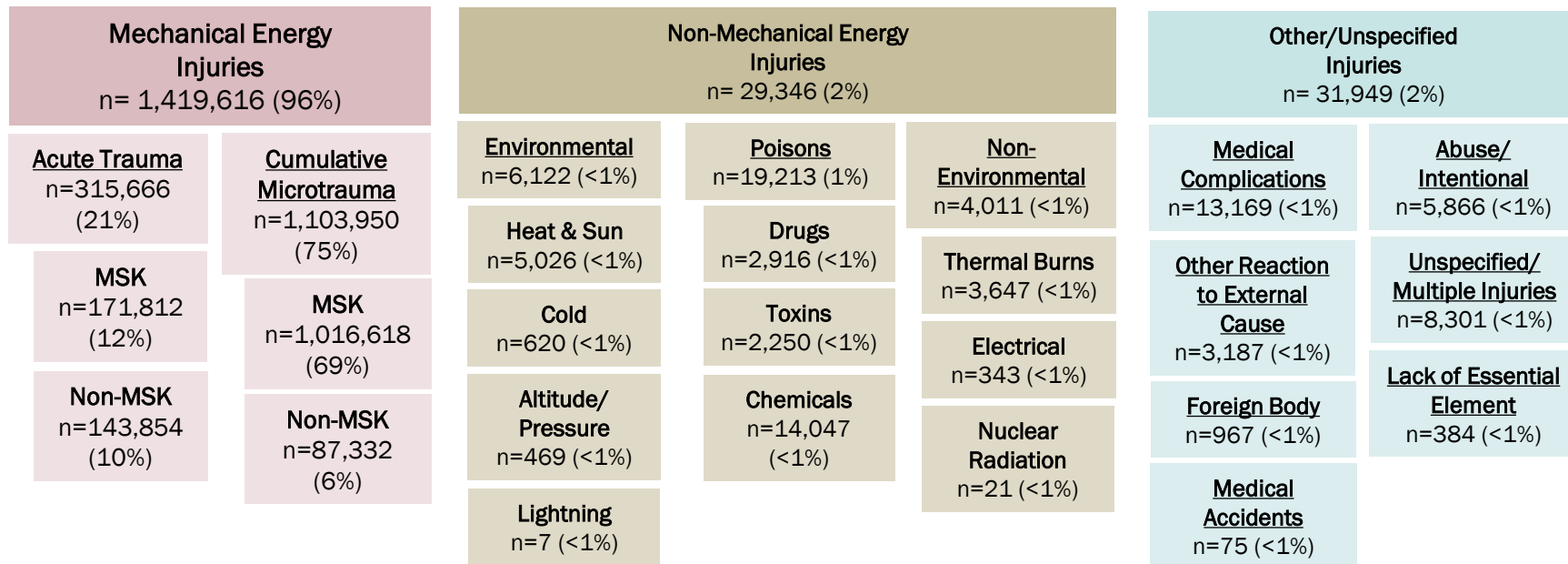
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Taxonomy Distribution of Injuries

U.S. All Services Active Duty, 2021

Incident Injuries, N = 1,480,911



Notes: *MSK = damage to tissue(s) of the musculoskeletal system (i.e., bone, cartilage, muscle, tendon, fascia, joint, ligament, bursa, or synovium)
For more information: <https://www.milsuite.mil/book/groups/aphc-injury-taxonomy>



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Musculoskeletal Injury Rates by Service

Service	Musculoskeletal (MSK) Injury Incidence per 1,000 Service Members		
	Acute	Cumulative MSK	All MSK
Army	194.7	1,097.3	1,292.0
Navy	119.5	632.0	751.4
Air Force	161.7	903.5	1,065.2
Marines	181.6	876.5	1,058.1
Space Force	164.3	727.2	891.5

Source: DHA-Public Health, Armed Forces Health Surveillance Division, 2024



Leading Reasons for Temporary Profiles

U.S. Army Active Duty, 2021

Temporary Profile Condition Types	Active Duty Army, January – December 2021					
	Men		Women		Total	
	# of days	(%)	# of days	(%)	# of days	(%)
Musculoskeletal Injury	6,712,913	(60.4)	2,019,857	(41.7)	8,732,785	(54.7)
Behavioral Health	1,354,527	(12.2)	441,701	(9.1)	1,796,228	(11.3)
Pregnancy	-	-	1,511,449	(31.2)	1,511,938	(9.5)
Post-COVID-19	746,904	(6.7)	146,508	(3.0)	893,412	(5.6)
Neurology/Neurosurgery	268,050	(2.4)	78,027	(1.6)	346,077	(2.2)
All Other	2,036,437	(18.3)	645,496	(13.3)	2,681,547	(16.8)
TOTAL	11,118,831	(100.0)	4,843,038		15,961,987	



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Jones BH, DM Perrotta, M Canham-Chervak et al. 2000. *Am J Prev Med* 18(3S):71–84.



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What causes the problem?

Examples of Lessons Learned from Army Surveillance Data, Surveys, and Epidemiologic Investigations



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Causes of Injury Temporary Profiles and Limited Duty Days U.S. Army Active Duty, 2021

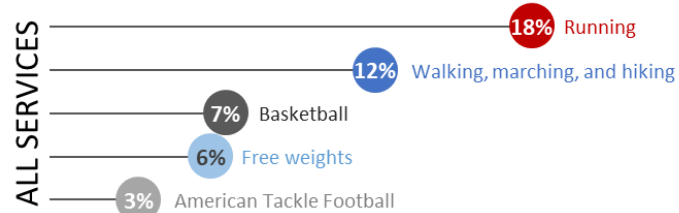
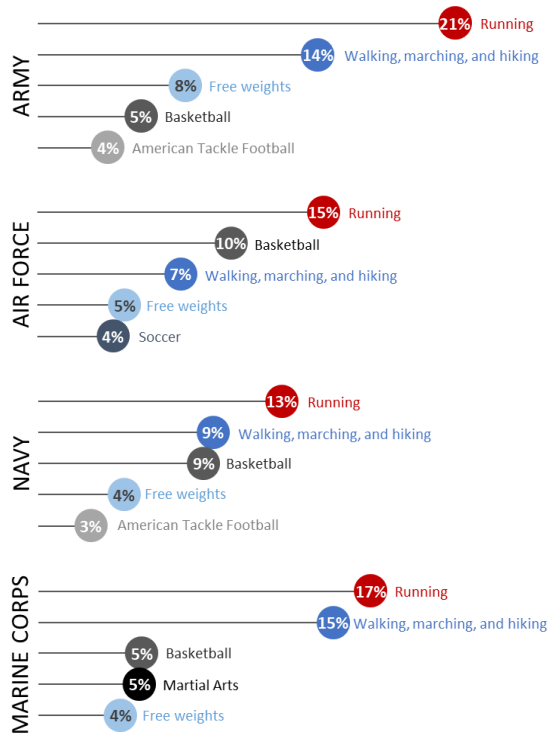
Injury Cause	Men		Women		All	
	LDD	%	LDD	%	LDD	%
Running	1,331,360	(19.3)	471,664	(22.5)	1,803,024	(20.0)
MOS work tasks:	704,839	(10.2)	182,072	(8.7)	886,911	(9.9)
- <i>Lifting</i>	240,001	(3.5)	61,789	(3.0)	301,790	(3.4)
- <i>Mechanical/repair</i>	60,776	(0.9)	8,165	(0.4)	68,941	(0.8)
- <i>Pushing or pulling objects</i>	28,363	(0.4)	6,795	(0.3)	35,158	(0.4)
- <i>Work tasks, other</i>	375,699	(5.4)	105,323	(5.0)	481,022	(5.3)
Gradual/ Insidious onset	556,094	(8.1)	215,914	(10.3)	772,008	(8.6)
Fall/ slip/ trip	495,165	(7.2)	124,103	(5.9)	619,268	(6.9)
Strength training	421,734	(6.1)	114,159	(5.5)	535,893	(6.0)
Road Marching/Load Carriage	397,825	(5.8)	135,161	(6.5)	532,986	(5.9)
Sports, individual or team	321,798	(4.7)	46,039	(2.2)	367,837	(4.1)
Physical Training, other	197,481	(2.9)	68,785	(3.3)	266,266	(3.0)
Motor Vehicle/Motorcycle Accident	166,372	(2.4)	41,931	(2.0)	208,303	(2.3)
Fast Rope, Parachute	160,349	(2.3)	20,836	(1.0)	181,185	(2.0)
ACFT Event, record or diagnostic	53,112	(0.8)	22,850	(1.1)	75,962	(0.8)
Combatives/Martial Arts/Fighting	45,118	(0.7)	3,554	(0.2)	48,672	(0.5)
Battle Injury	15,895	(0.2)	886	(0.0)	16,781	(0.2)
Environmental, heat or cold	2,011	(0.0)	298	(0.0)	2,309	(0.0)
Total, excluding Unknown	4,869,153	(70.5)	1,448,252	(69.2)	6,317,405	(70.2)



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Activities by Service, 2021



Among the top five unique activities leading to unintentional injury:

- Running is the single most common activity across all Services, followed by walking, marching, and hiking. These activities can account for the high proportion of lower extremity and spine & back injuries seen across all Services, particularly among Soldiers and Marines.
- Activities among Soldiers and Marines were concentrated in fewer single activities than the other Services, with more than 30% of their total injury-related activities being running, walking, marching, or hiking.
- The activities leading to injury were more broadly distributed among Airmen and Sailors.
- Basketball was the most common recreational sport leading to injury, particularly among Airmen and Sailors.

Total number of unintentional incident injury encounters with activity codes = 41,753 (3%); may not be representative of the distribution of activities for all incident injuries.



Self-Reported Leading Activities Associated with Injury

Survey of Active Duty Service Members

Sports, Exercise, or Recreational Activity	Army n=125,684 Percent	Navy n=57,502 Percent	Marine Corps n=51,745 Percent	Air Force n=63,390 Percent	Total n=298,320 Percent
Running or jogging (outdoors)	50.3	33.2	50.6	41.3	45.1
Weight training	6.4	8.9	6.6	9.6	7.6
Basketball	7.3	10.1	3.5	8.6	7.5
Touch or flag football	4.8	6.0	4.4	5.6	5.1
Martial arts	4.5	3.0	9.1	1.1	4.3
Softball or baseball	1.5	6.3	1.3	5.9	3.3
Soccer	2.0	3.6	5.4	3.6	3.2
Other	23.2	28.9	19.2	24.4	23.9

Source: Hauret KG et al. 2015. "A Survey of Military Servicemembers." *Am J Sports Med* 43(11):2645-53.

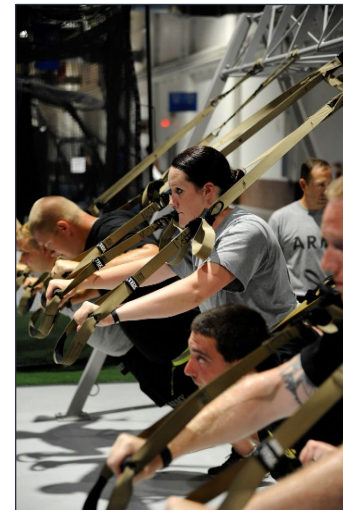
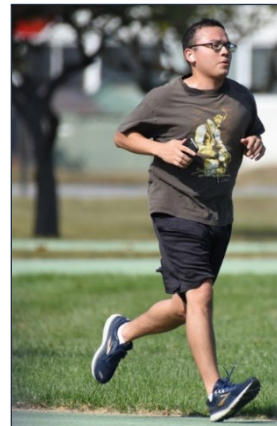


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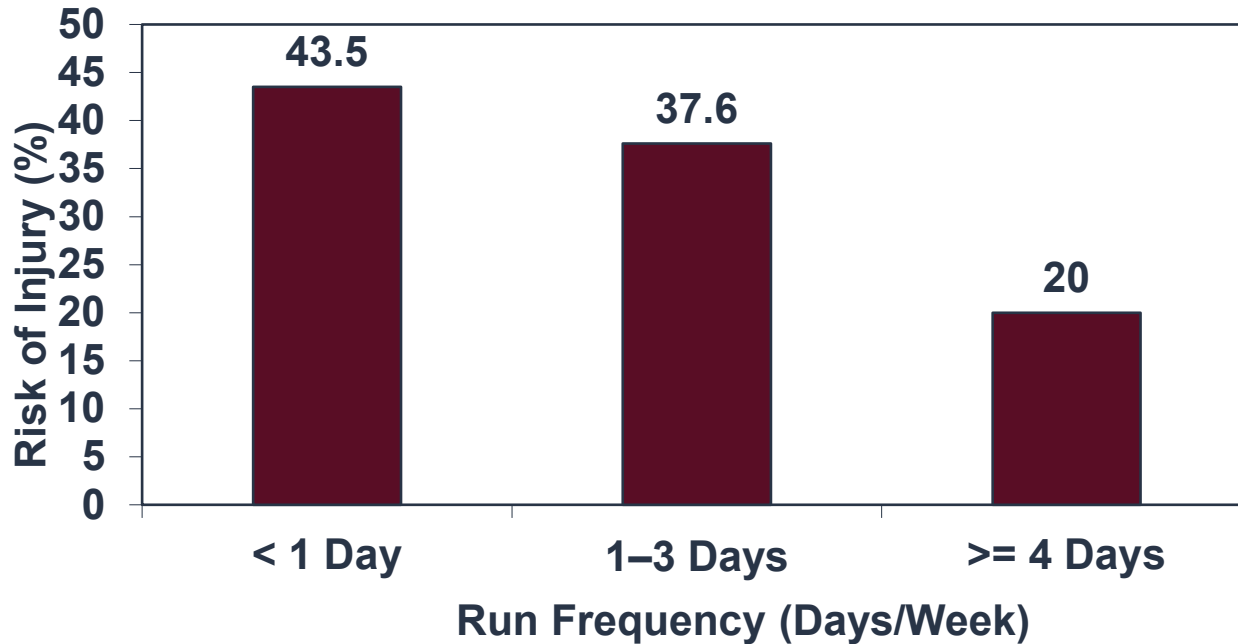


Focus on *Training-Related Injuries*: Factors Affecting Risk

- Amount of past physical activity
- Amount of current physical activity
- Type of current activity
- Levels of physical fitness
- Demographics/effect modifiers (age, gender)



Days Run per Week in the Month Before Initial Entry Training* and Injury Risk in Male Army Trainees



* Initial Entry Training (IET), 12 Weeks, Fort Benning, GA, 1987
n=289 Trainees (0-1 days=108; 1-3 days=149; >4 days=45)
RR_{0-1 days/>4 day} =2.2, 95% CI: 1.2-4.1

Source: Jones BH. 1993. MSSE 25(2):197-203

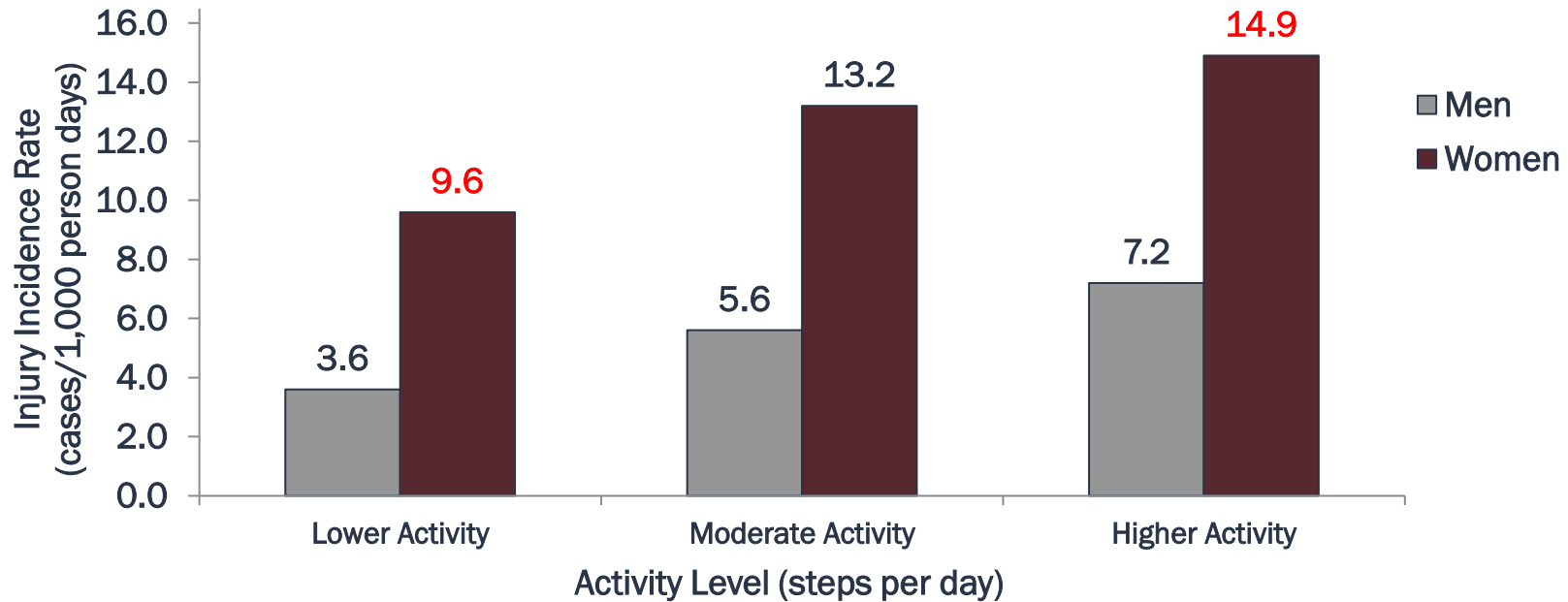


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Footsteps and Injury Risk for Female and Male Trainees During Basic Combat Training



Average footsteps per day: Lower=14,772 ± 400; Moderate=16,346 ± 768; Higher=17,948 ± 550

Men (n=1,174) Hazard ratios: High vs. Low 1.94 (p<0.01), Moderate vs. Low 1.52 (p<0.01)

Women (n=898) Hazard ratios (adjusted for initial push-up, sit-up, and 2-mile run differences):

High vs. Low 1.43 (p<0.01), Moderate vs. Low 1.30 (p<0.05)

Source: Knapik J et al. 2011. *JPAH* 8:496–502.



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Running Mileage, Lower Extremity Injury Rates, and Run Time in Infantry Initial Entry Training

Mileage	Injury Incidence	2-Mile Run Time*
Low (n=146)	32.5%	13:29
High (n=157)	41.8%	13:45

* Final Army Physical Fitness Test (APFT) average run times
 RR, high vs. low=1.3 (95% CI: 1.0-1.8)
 Low mileage=56 miles/12 weeks; High mileage=130 miles/12 weeks

Source: Jones BH et al. 1994. *Sports Med* 18(3):202-14



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Road Marching Mileage and Injury Rates

U.S. Army Infantry Brigade

Road March Distance	Injuries* per 10,000 person-days	Relative risk of Injury resulting in limited duty
Low Mileage	5	1.0
Moderate Mileage	5	1.0
High Mileage	7	1.4

n=736

Low Mileage: ≤19 miles per month

Moderate Mileage: 20-32 miles per month

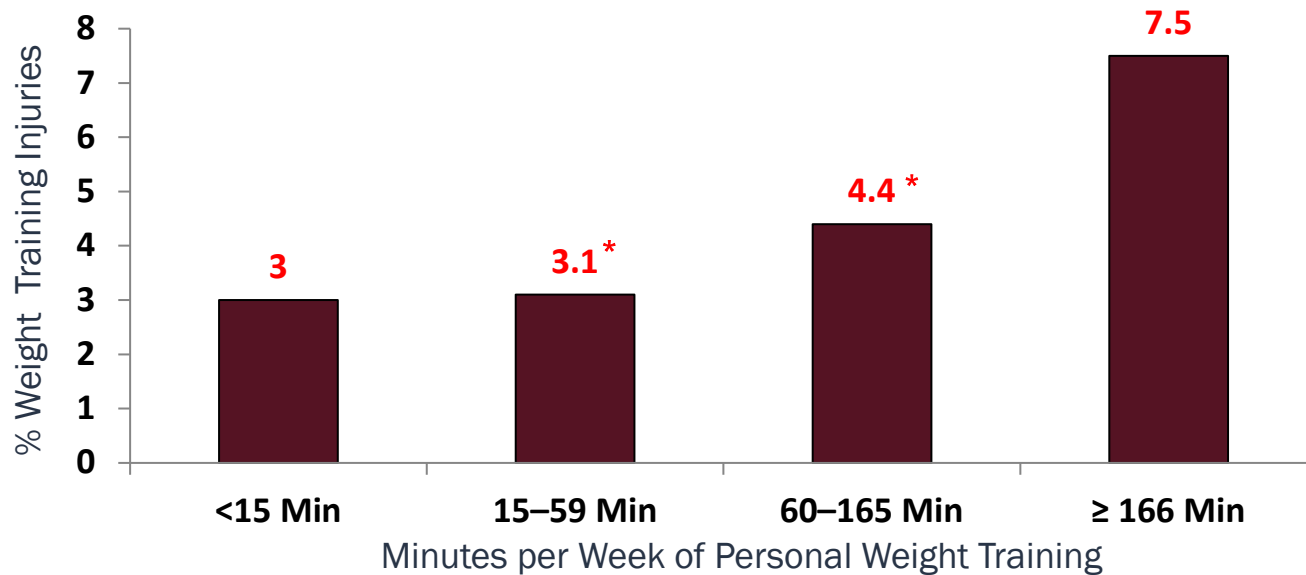
High Mileage: ≥33 miles per month

* Injuries associated with road marching only

Source: Schuh A et.al. 2017. "Risk factors for injury associated with low, moderate, and high mileage road marching in a U.S. Army infantry brigade." *J Sci Med Sport* 20(Suppl 4):S28–33.



Weight Training Injury by Frequency of Weight Training U.S. Army Male Infantry Soldiers



Linear Trend $p < 0.01$; *statistically significant difference compared to ≥ 166 (2.75 hr) group

RR (<15 vs. ≥ 166) = 2.5 (95%CI: 0.9, 6.9)

RR (15–59 vs. ≥ 166) = 2.4 (95%CI: 1.5, 3.8)

RR (60–166 vs. ≥ 166) = 1.7 (95%CI: 1.2, 2.5)

Source: Grier T, R Brooks, Z Solomon, and BH Jones. 2022. "Injury Risk Factors Associated with Weight Training." *J Strength Cond Res* 36(2):e24–30.



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Focus on *Training-Related Injuries*: Factors Affecting Risk

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- **Type of current activity**
- Levels of physical fitness
- Demographics/effect modifiers (age, gender)



Risks of Injury per Miles of Exposure for Military Activities in an Infantry Brigade

Military Training Activity	Rate of injury <i>per 10,000 miles</i>	Relative risk of injury (95% CI)
Running	3.3	1.00
Road Marching	5.9	1.81 (1.38–2.37)

n=831

Source: Schuh-Renner A et al. 2017. "Risk factors for injury associated with low, moderate, and high mileage marching in a US Army infantry brigade." *J Sci Med Sport* Suppl 4:28–33.



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Unadjusted Rates of Injury per Training Hours for Military Activities in Initial Entry Training, 2010–2011

Military Training Activity	Rate <i>per 1,000 person-hours</i>	Relative Rate
Physical Training	2.2	1.0
Road Marching	10.5	4.8
Obstacle Course	16.5	7.5

n=5,894 (Men=3,481; Women=2,413)

Source: Knapik J et.al. 2013. “Activities Associated With Injuries in Initial Entry Training.” *Mil Med* 178(5):500–6.



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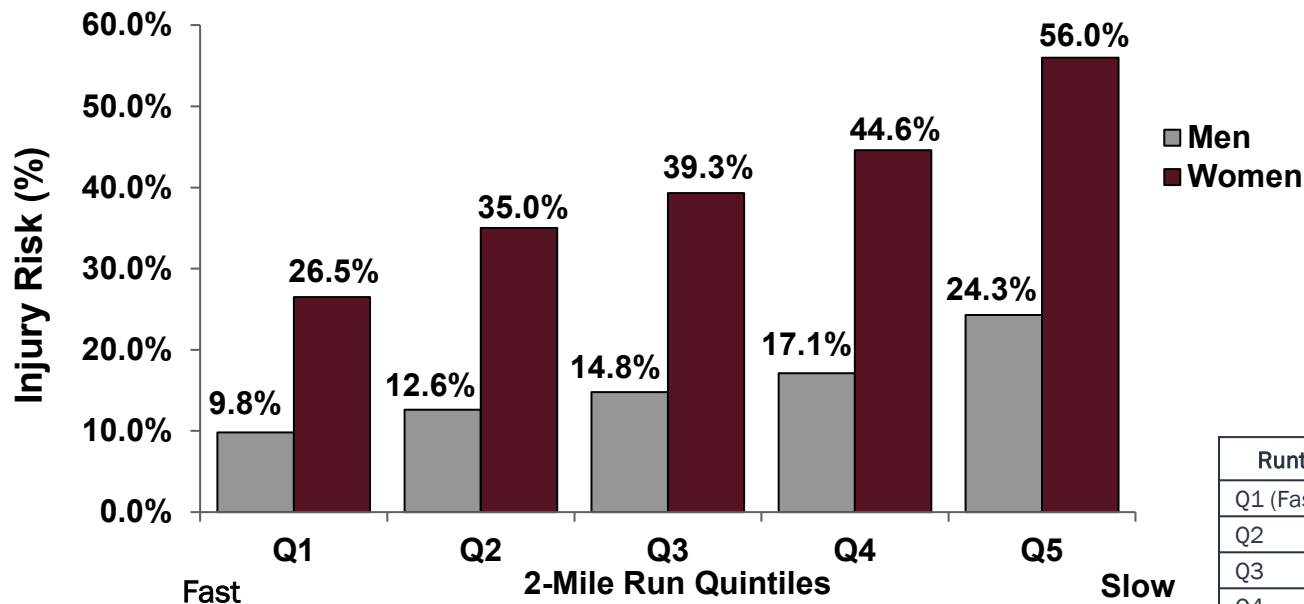


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Aerobic Endurance 2-Mile Run Times and Injury Risk for Men and Women in Basic Combat Training



Runtime	Men	Women
Q1 (Fastest)	<13.5	<16.2
Q2	13.5-14.2	16.2-17.3
Q3	14.3-15.0	17.4-18.1
Q4	15.1-15.8	18.2-19.0
Q5 (Slowest)	>15.8	>19.0

n = 184,598 (Men=143,159, Women=41,439)

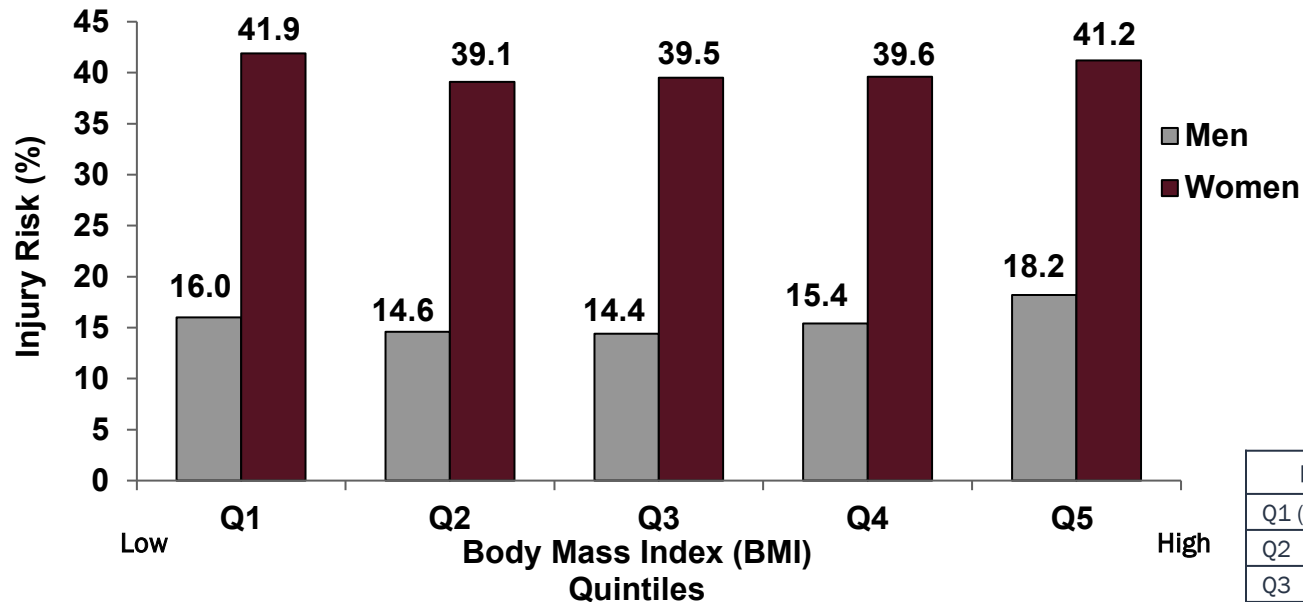
Men: RR Q1 vs. Q5=2.5 (p<0.001)

Women: RR Q1 vs. Q5=2.1 (p<0.001)

Source: Jones BH, et.al. 2017. JSAMS 20(Suppl 2):S14-22.



Body Mass Index (BMI) and Injury Risk for Men and Women in BCT



BMI	Men	Women
Q1 (Lowest)	<21.7	<20.7
Q2	21.7–23.8	20.7–22.6
Q3	23.9–25.9	22.7–24.2
Q4	26.0–28.3	24.3–25.6
Q5 (Highest)	>28.3	>25.6

n=184,598 (Men=143,159, Women=41,439)

RR, Q1 vs. Q5: Men (1.1, p<0.001), Women (1.0, p=0.36)

RR, Q1 vs. Q3: Men (1.1, p<0.001), Women (1.1, p<0.05)

RR, Q5 vs. Q3: Men (1.3, p<0.001), Women (1.1, p<0.05)

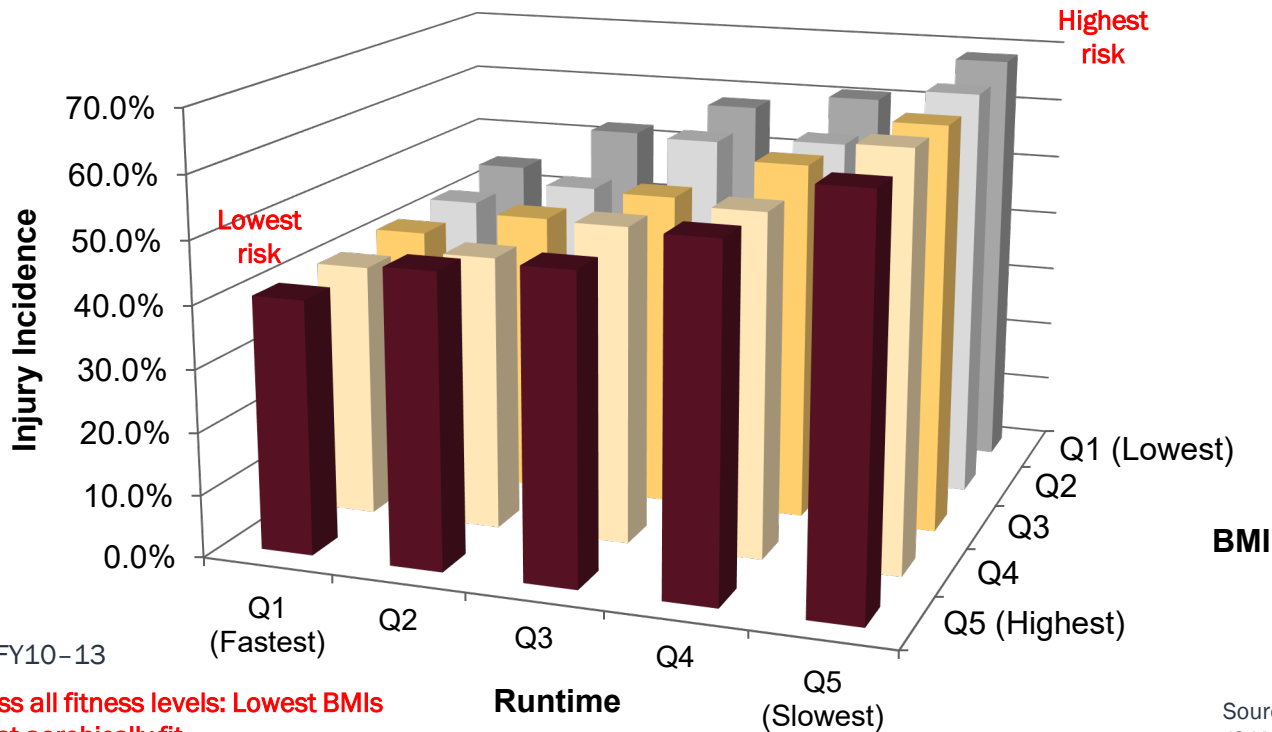
Source: Jones BH et.al. 2017. JSAMS 20(Suppl 2):S14–22.



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Injury Incidence by 2-Mile Run Time and Body Mass Index, Women



34,931 women, FY10-13

Highest risk across all fitness levels: Lowest BMIs
Lowest risks: Most aerobically fit

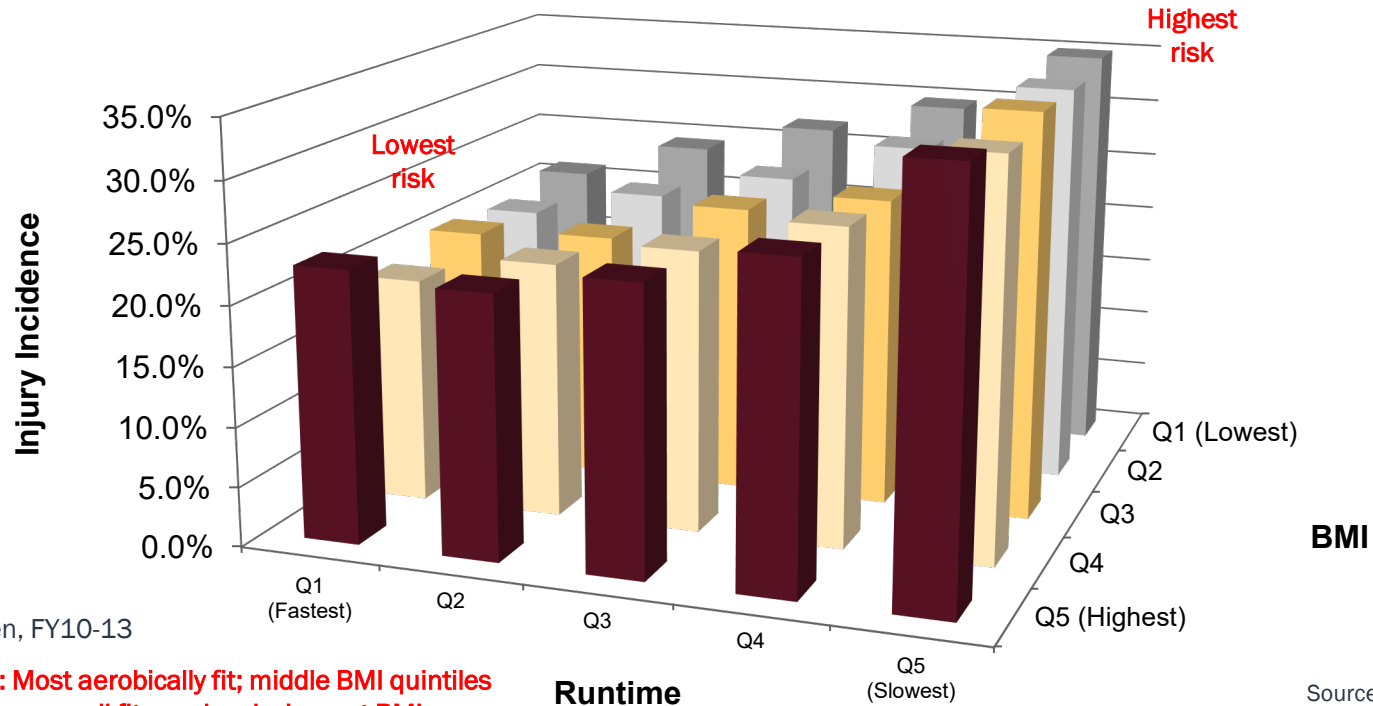
Source: Jones BH et.al. 2017.
 JSAMS 20(Suppl 2):S14-22.



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Injury Incidence by 2-Mile Run Time and Body Mass Index, Men



136,797 men, FY10-13

Lowest risks: Most aerobically fit; middle BMI quintiles
Highest risk across all fitness levels: Lowest BMIs

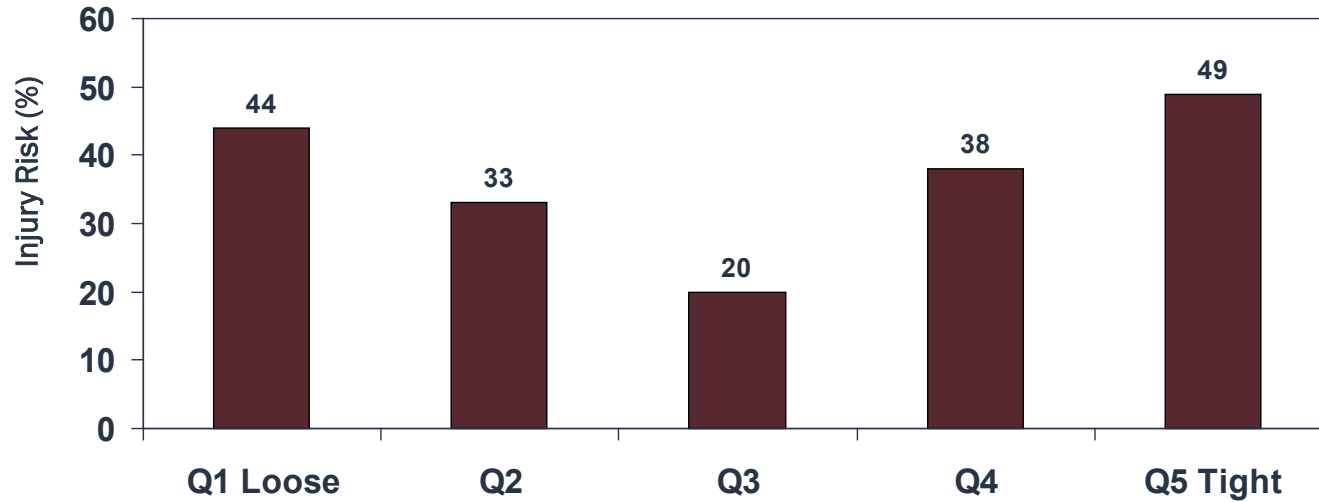
Source: Jones BH et.al. 2017.
 JSAMS 20(Suppl 2):S14-22.



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Flexibility (Sit and Reach) and Injury Risk, Males, Infantry Basic Training



Fort Benning, 1987; n=303, Median=4.3cm (range=-24 to +28)

RR, Q1 vs. Q3=2.2, p-value <0.05

RR, Q5 vs. Q3=2.5, p-value <0.05

Source: Jones BH et al. 1993. MSSE 25(2):197-203.



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Age and Injury Risk

- Military studies showing older age associated with higher risk of injury
 - Brudvig TJ et al. 1983. *Mil Med* 148(8):666–67.
 - Gardner LI et al. 1988. *AJPH* 78(12):1563–67.
 - Jones BH et al. 1993. *MSSE* 25(2):197–203.
 - Knapik JJ et al. 2006. *Mil Med* 171(1):45–54.
 - Knapik JJ et al. 2001. *MSSE* 33(6):946–54.
 - McKean KA et al. 2006. *Clin J Sport Med* 16(2):149–54.
 - Shaffer RA et al. 1999. *AJE* 149:136–42.
 - Taunton JE et al. 2003. *BJ Sports Med* 37(3):239–44.
- Military studies showing older age associated with lower risk of injury
 - Carlson SA et al. 2006. *Ann Epi* 16:712–19.
 - Colbert LH et al. 2000. *Clin J Sport Med* 10(4):259–63.
 - Hootman JM et al. 2002. *Clin J Sport Med* 12(2):99–106.
 - Knapik JJ et al. 1993. *JOM* 35:598–603.



Sex and Injury Risk during Army Basic Training

Study	Year	Women (%)	Men (%)	RR*
Kowal	1980	54	26	2.1
Bensel	1982	41	21	2.0
Jones	1984	50	28	1.8
Bell	1988	62	29	2.1
Canham	1995	64	42	1.6
Knapik	2000	47	17	2.8
Knapik	2003	48	28	1.7

*Relative Risk

1. Kowal D. 1980. *Am J Sports Med*; 8(4):265–69.
2. Bensel C. 1982. Army Technical Report, Natick, MA.
3. Jones BH et al. 1992. National Academies Press.
4. Bell N et al. 2000. *Am J Prev Med* 18(Suppl 3):141–46.
5. Canham ML et al. 1998. In: *Advances in Occupational Ergonomics and Safety, Vol. 2.* ed. S. Kumar. Amsterdam, Netherlands: IOS Press.
6. Knapik JJ et al. 2003. *Int J Sports Med* 24(5):372–81.
7. U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). 2003. Army Technical Report prepared by JJ Knapik, Aberdeen Proving Ground, MD.



Incidence of Injury, Women and Men in Operational Units

Study	Year	Women (%)	Men (%)	RR*
Fort Campbell	2016	42	35	1.2
Fort Stewart	2014–15	--	37	n/a
Fort Carson	2011–12	29	30	1.0
Chemical Brigade	2013–14	77	66	1.2
Sergeants Major Academy	2013–14	--	57	n/a
Schofield Barracks	2009–10	60	45	1.3

*Relative Risk

1. APHC. 2018. *Epidemiological Investigation of the Rehabilitation Readiness Training Program Baseline Survey, Apr–Jul 2016.*
2. APHC. 2017. *Survey of Injuries and Injury Risk Factors in the 2nd Brigade Combat Team, 3rd Infantry Division, Nov 2014–Jan 2015.*
3. APHC. 2017. *Deployment Injuries and Injury Risk Factors in a Light Infantry Brigade Combat Team, May 2011–May 2012.*
4. APHC. 2015. *Injury Rates, Limited Duty Days, Medically Not Ready Days, and Injury Risk Factors in an Army Chemical Brigade, May 2013–Jun 2014.*
5. APHC. 2016. *Evaluation of Student Injuries at the Sergeants Major Course (SMC), Fort Bliss, Texas, Aug 2013–May 2014.*
6. APHC. 2019. *Injury Surveillance and Longitudinal Studies for Gender Integration in the Army: Third Annual Assessment, 2018.*
7. APHC. 2012. *Evaluation of the Advanced Tactical Athlete Conditioning Programs in the 25th Infantry Division, Schofield Barracks, Hawaii.*

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Injury Surveillance Quarterly Reporting, 16 Gender-Integrated Brigades, 2021

July – September 2021		Combined Total 16 Brigades			Infantry & Armor Occupational Specialties			All Other Occupational Specialties		
		Total	M	W	Total	M	W	Total	M	W
	Assigned Strength (n)	73,235	65,617	7,618	28,638	28,192	446	44,597	37,425	7,172
Musculoskeletal (MSK) Injuries	Soldiers Injured (%)	17%	17%	22%	16%	16%	16%	18%	17%	22%
	Number of Injuries (n)	18,062	15,560	2,502	6,529	6,410	119	11,533	9,150	2,383
	Injury Rate (injuries per 100/mo.)	8.2	7.9	10.9	7.0	7.0	9.0	9.0	8.6	11.0
Injury Type	Traumatic Injuries (%)	15%	15%	10%	16%	16%	9%	14%	15%	10%
	Overuse Injuries (%)	85%	85%	90%	84%	84%	91%	86%	85%	90%
Anatomic Location	Upper Extremity (%)	20%	21%	15%	20%	20%	21%	20%	21%	15%
	Lower Extremity (%)	53%	52%	57%	53%	52%	57%	53%	52%	57%
	All Other (%)	27%	27%	28%	27%	28%	22%	27%	27%	28%



Gender-Integrated Occupations: Musculoskeletal Injury Rates Enlisted and Officers, Army Active Component, CY 2021

Enlisted MOS Functional Category ^a	Women		Men		Injury Rate Ratio (W/M) ^c
	Person-yrs.	Injury Rate ^b	Person-yrs.	Injury Rate ^b	
Operations	5,011	2,071	134,657	1,272	1.63 (1.60–1.66)*
Operations Support	14,389	1,951	75,868	1,352	1.44 (1.42–1.46)*
Force Sustainment	37,106	2,062	112,788	1,539	1.34 (1.33–1.35)*
Overall	56,506	2,034	323,313	1,384	1.47 (1.46–1.48)*
Officer AOC Functional Category ^a	Women		Men		Injury Rate Ratio (W/M) ^c
	Person-yrs.	Injury Rate ^b	Person-yrs.	Injury Rate ^b	
Health Services	5,702	1,403	9,084	1,141	1.23 (1.19–1.27)*
Army Special Operations	128	2,382	2,446	1,970	1.21 (1.08–1.36)*
Operations	3,220	1,306	26,090	1,094	1.19 (1.16–1.23)*
Operations Support	1,949	1,699	9,857	1,497	1.13 (1.09–1.18)*
Force Sustainment	4,162	1,630	12,980	1,432	1.14 (1.11–1.17)*
Overall	15,162	1,424	60,457	1,275	1.17 (1.15–1.19)*

Source: Defense Medical Surveillance System, 2022; prepared by DCPH-A Injury Prevention Branch

Abbreviations: MOS = military occupational specialty; AOC = area of concentration; yrs. = years

Notes:

^a Functional Categories (as defined by Human Resource Command)

^b Injury Rate: Number of MSK injuries per 1,000 Soldiers per year

^c Injury rate ratio (W/M): injury rate among women / injury rate among men

* Rate Ratio (W/M) is statistically significant ($p < 0.05$) for the functional category



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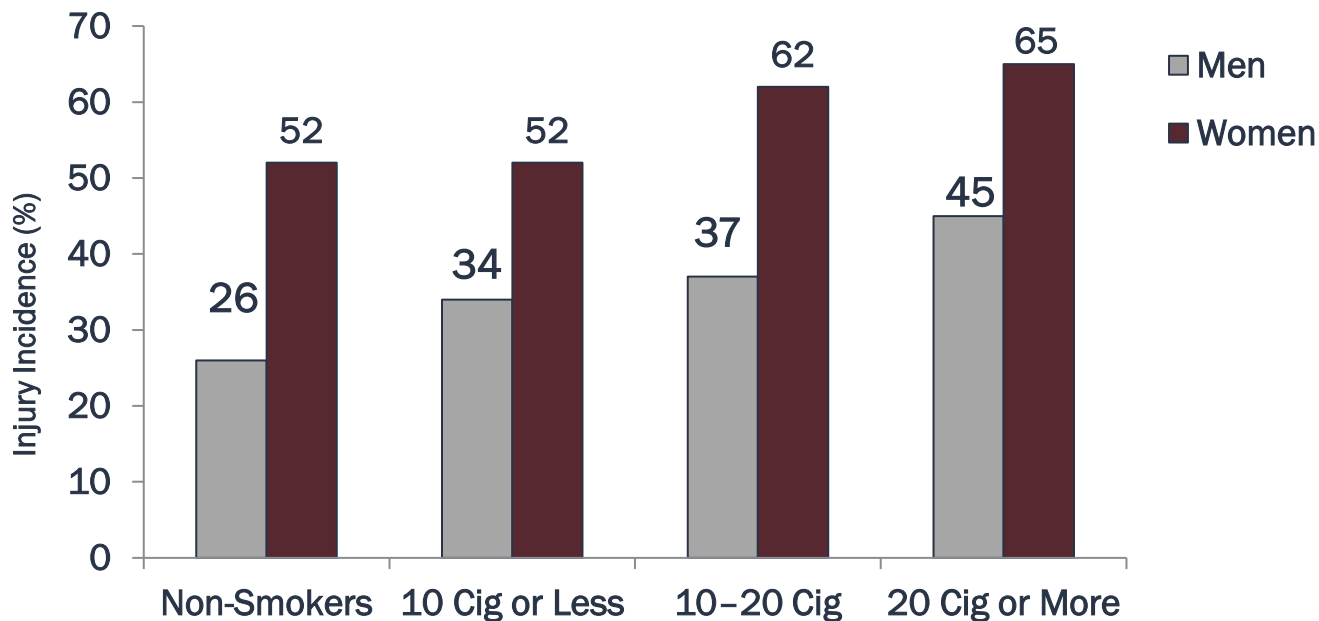
Behavioral Risk Factors



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Cigarette Smoking and Injury in Basic Training



Basic Training (Men=3,757, Women=498)

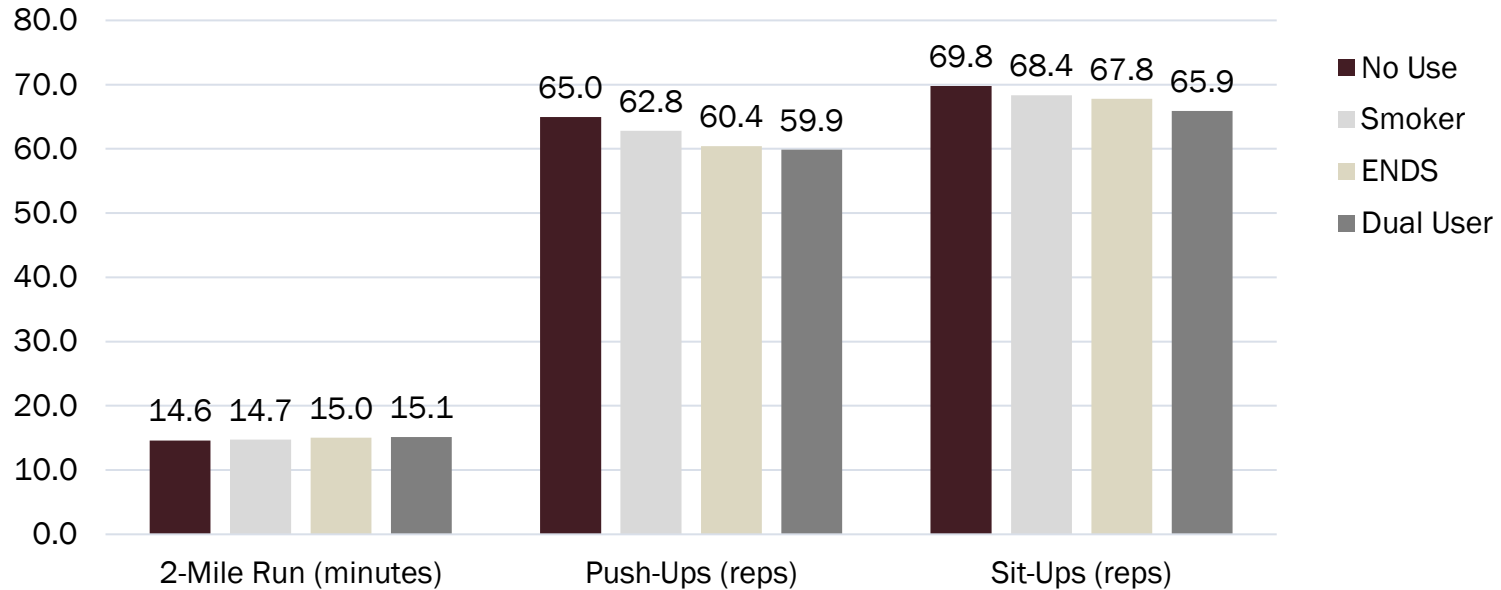
Non-smokers vs. 20 or more cigarettes: Men RR=1.7 (p<.001); Women RR=1.2 (p=0.12)

Test for trend: Men p<0.05; Women p=0.06

Source: Grier T et al. 2011. "Risk factors for injuries in the U.S. Army Ordnance School." *Mil Med* 176(11):1292-9.



Tobacco Use and Physical Performance on the Army Physical Fitness Test



n=2,854 Male Soldiers

ENDS = Electronic Nicotine Delivery System

Dual User = Cigarettes + ENDS

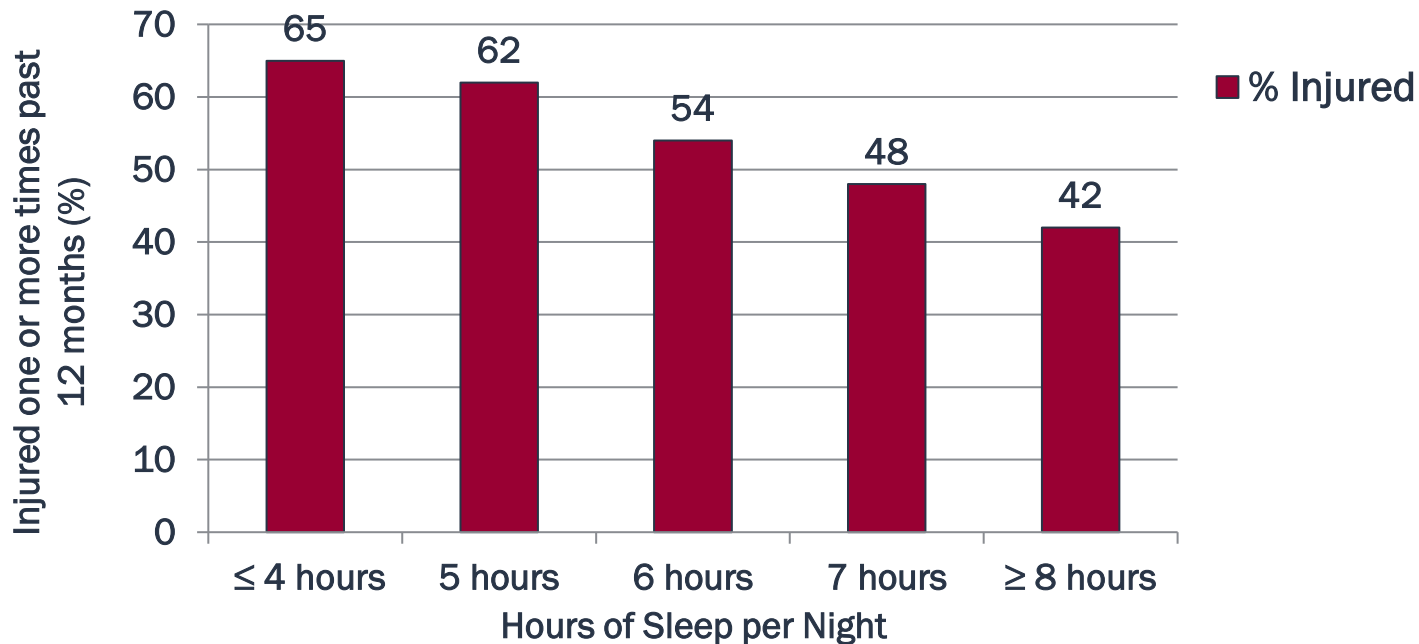
Source: Dinkeloo E, T Grier, R Brooks, and BH Jones. 2020. "Vaping, Smoking, and the Physical Fitness of Active Young Men: A Study of U.S. Army Soldiers." *Am J Prev Med* 58(1):e31–e37.



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Sleep Duration and Musculoskeletal Injury Risk



Active Duty Special Operations Forces (SOF) Soldiers:
Men n=7207, Women n=374

Source: Grier T et al. 2020. *Sleep Health* 6(3):344-49.



Public Health Approach to Injury 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 and field investigations
3. Intervention trials and systematic reviews
4. Program and policy implementation
5. Program evaluations and monitoring

Sources:

Jones BH, VD Hauschild, and M Canham-Chervak. 2018. *J Med Sci Sport* 21(112):1139–46.

Jones BH, DM Perrotta, M Canham-Chervak et al. 2000. *Am J Prev Med* 18(3S):71–84.



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Army Brigade Combat Team Injury Prevention 2003 TRADOC Program Implementation

- New Standardized policies and programs for physical training (PT) were implemented to **prevent overtraining**.
 - Reduced number of miles run during 9 weeks of BCT
 - Conducted distance runs by ability groups (fittest ability group: 37 miles total; least fit: 24 miles)
 - Added speed drills (4 to 5 miles total)
 - Balanced PT program (e.g., substitute grass drills for running)



Standardized vs. Traditional Physical Training Programs, Male Trainees, Fort Jackson, 2003

	Traditional PT*	Standardized New PT*	Rate Ratio (95% CI)
Injury Rate (n/100)	31.3%	21.8%	1.4 ^a (1.1-1.7)
APFT % Passing	84.4%	88.4%	0.9 ^b (0.8-1.0)
% Attrition	7.0%	6.0%	1.2 ^c (0.7-1.6)

Notes:

^a p-value: Injured Traditional/Standardized < 0.001

^b p-value: % Pass APFT Traditional/Standardized = .05

^c p-value % Attrition Traditional/Standardized = 0.48

*Traditional PT N = 656; Standardized PT N = 518;

Avg. final 2-mile run times: Traditional, men = 14.9 mins; Standardized, men = 14.8;

Traditional, women = 18.0; Standardized, women = 17.8 mins.

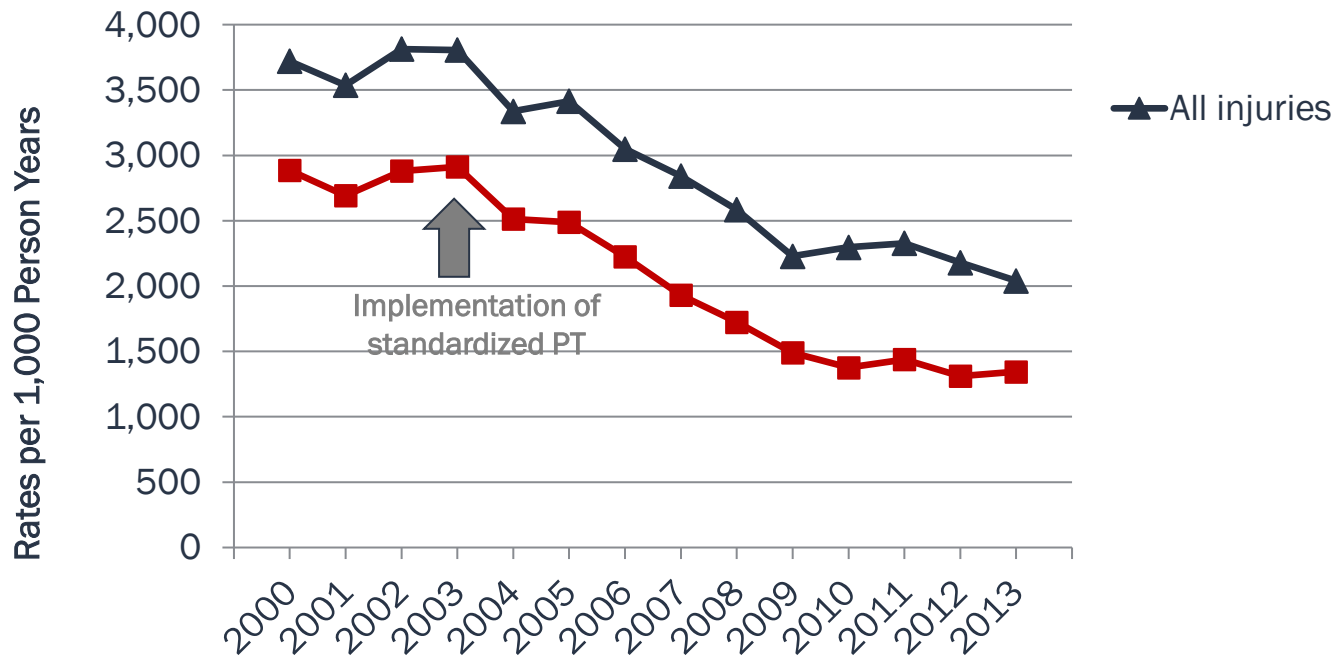
Sources:

USACHPPM. 2004. Report No. 12-HF-5772B-04, by Knapik JJ et al. Aberdeen Proving Ground, MD.

Knapik JJ et al. 2005. *J. Strength Cond Res* 19(2):246–53.



U.S. Army Trainee Injury and Lower Extremity Overuse Injury Rates, 2000-2013



Source: APHC. 2014. *Health of the Force 2015*. Aberdeen Proving Ground, Maryland.

Data source: Defense Medical Surveillance System, 2014; prepared by APHC Injury Prevention Program.

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Foot Type and Shoe Type



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Foot Type and Shoe Type



FLAT (LOW)
ARCH



NORMAL
(MEDIUM) ARCH



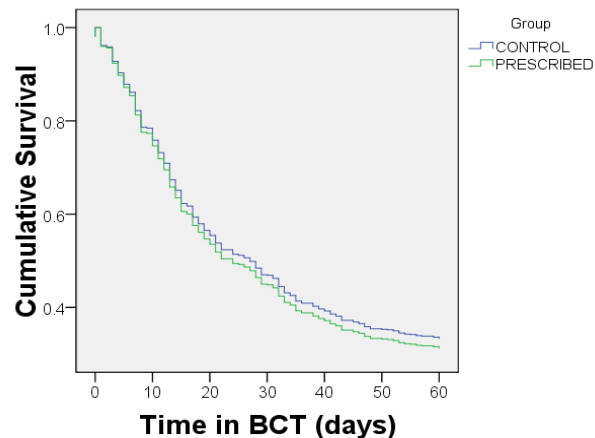
HIGH
ARCH

ILLUSTRATIONS BY CHARLIE LAYTON



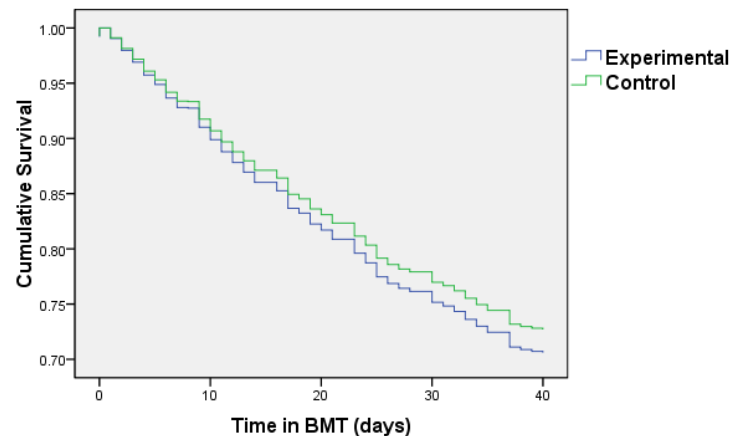
Effect on Injuries of Assigning Running Shoes Based on Foot Arch Height

Army: Injuries in Control and Prescribed Group Men



HR (Prescribed/Control)=1.02, 95%CI=0.89–1.17

Air Force: Injuries in Control and Experimental Group Men



HR (Exp/Control)=1.09, 95%CI=0.92–1.29

Sources:

Knapik J et al. 2009. *J Strength Condit Res* 23(4):1353–62.

Knapik J et al. 2010. *Am J Prev Med* 38(Suppl 1):S197–211.



Self-Selected Shoe Type and Injury Risk

Shoe Type	n	% Injured	Risk Ratio (95% CI)	p-value
Motion Control	56	45%	1.13 (0.82–1.57)	0.47
Stability	616	44%	1.11 (0.94–1.32)	0.22
Cushioning	1,052	41%	1.03 (0.87–1.22)	0.72
Minimalist	264	39%	1.00 (-----)	

Sources:

Grier T et al. 2016. "Minimalist Running Shoes and Injury Risk Among U.S. Army Soldiers." *Am J Sports Med* 44(6):1439–46.

4th ID, Fort Carson; visible shoe inspection and DMSS medical encounters



Systematic Reviews of Other Training Injury Prevention Strategies

- **Stretching – no or minimal evidence** (Aaltonen et al. 2007; Behm et al. 2016; Dijkstra et al. 2020; Herbert & Gabriel 2002; Lauersen et al. 2014; Leppanen et al. 2014; Lewis 2014; Shrier 1999; Small et al. 2008; Stephenson et al. 2021; Thacker et al. 2004; Weldon & Hill 2003).
 - Causal relationship between insufficient flexibility and increased injury risk is not established to warrant mandatory stretching. Nevertheless, alternative interventions, e.g., strength training, improve flexibility (Afonso et al. 2021; Alizadeh et al. 2023). More research is required.
- **Footwear – inconclusive and low-quality evidence** (Andersen et al. 2016; Arslan et al. 2021; Bonanno et al. 2017; Orr et al. 2022; Paradise et al. 2021).
 - Second order effects that impact physical performance and mechanisms of injury are needed.
- **Nutrition–inconclusive.** Promising lines of research include vitamin D, calcium, protein intake potentially due to second order effects (Arslan et al. 2021; Azzolino et al. 2021; Close et al. 2019; Turnagol et al. 2022; Webster et al. 2023).
 - It is important to distinguish injury prevention from injury recovery even though the two are interrelated.



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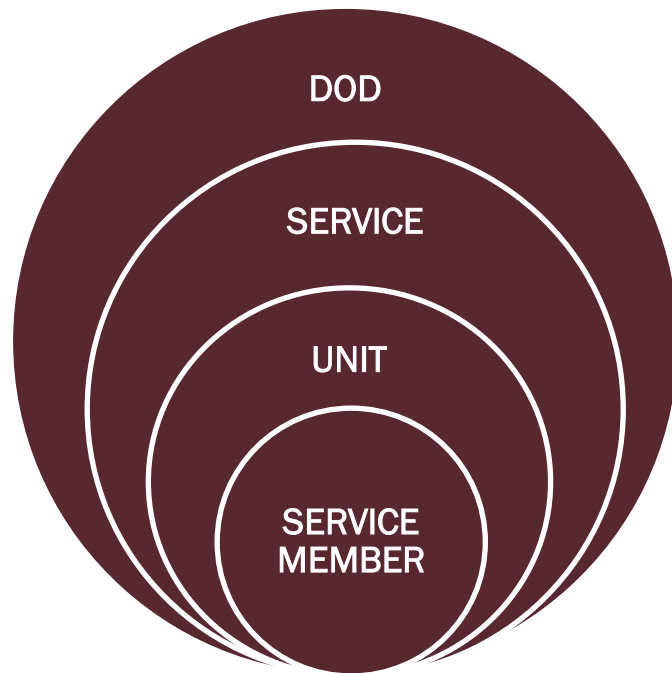
Jones BH, DM Perrotta, M Canham-Chervak et al. 2000. *Am J Prev Med* 18(3S):71–84.



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Multi-Level Prevention Efforts



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Example Application of Science: Army Wellness Center Musculoskeletal Injury Prevention Pilot

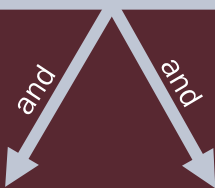
AWC Services address modifiable MSK injury risk factors:

- Low levels of aerobic fitness
- High and low % BMI
- Tobacco use
- Inadequate sleep

AWC referral criteria – males

Primary Indicator 2-mile Run time
 $\geq 15:00$ minutes

Secondary Indicator

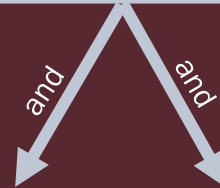


BMI ≤ 19 kg/m² or ≥ 27.5 kg/m²

AWC referral criteria – females

Primary Indicator 2-mile Run time
 $\geq 18:00$ minutes

Secondary Indicator



BMI ≤ 21 kg/m² or ≥ 27.5 kg/m²

Public Health Approach to Injury Prevention

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Jones BH, DM Perrotta, M Canham-Chervak et al. 2000. *Am J Prev Med* 18(3S):71–84.

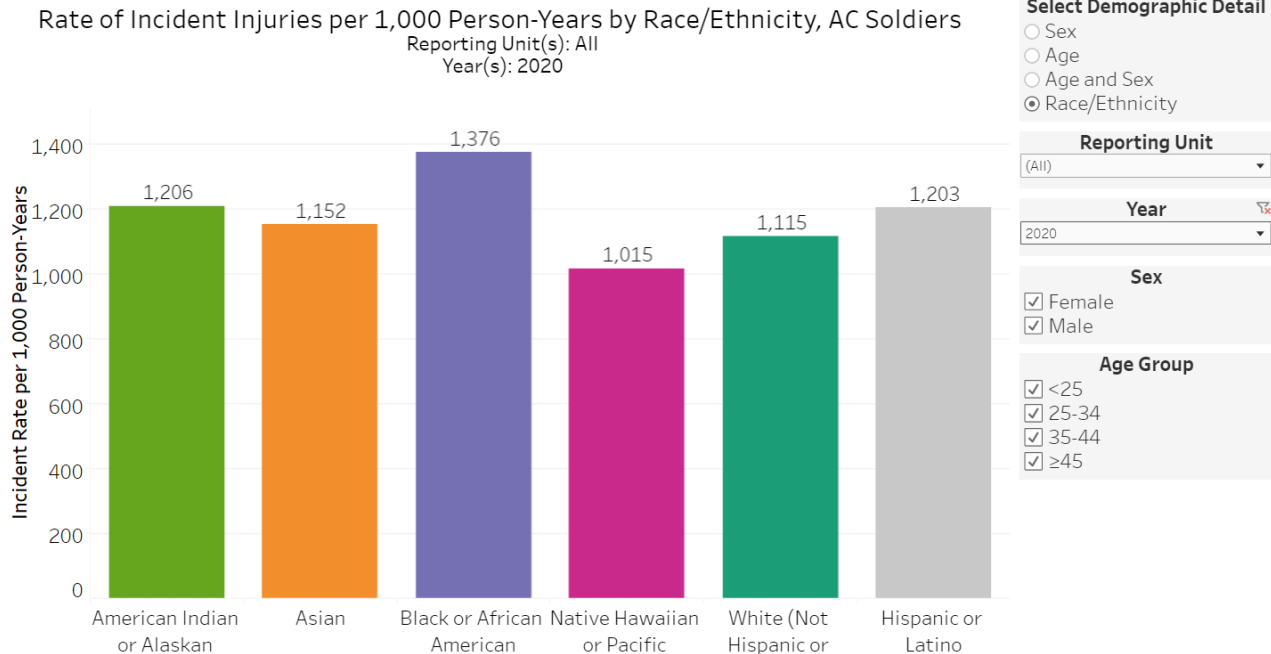


Example Monitoring Product: Health of the Force Online

Interactive dashboard of installation-level metrics



<https://carepoint.health.mil/sites/HOF/Pages/Home.aspx>

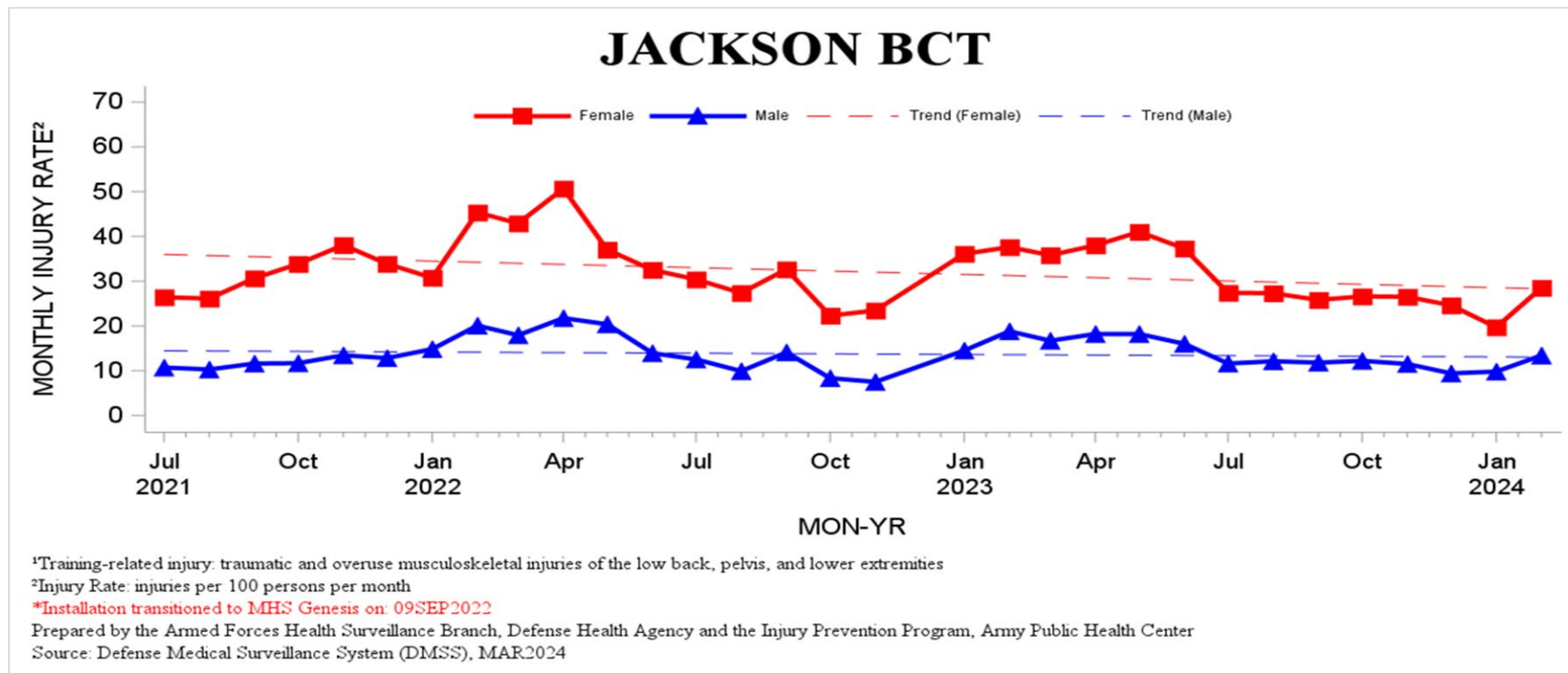


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Example Monitoring Product: Training-Related Injury Reports

Monthly distribution to Army initial entry training (IET) locations



Summary

Injuries are a leading readiness issue

- Over 4.9 million injury-related medical encounters annually, affecting over 600,000 Service Members
- Majority of new injuries (96%) due to mechanical energy sources; 75% due to cumulative micro-trauma or “overuse”
- In U.S. Army, result in over 8 million limited duty days

Running is the leading cause of injuries across Services

- Across various types of physical activity, greater amounts increase injury risk
- Must consider activity type and total exposure
- Thresholds exist above which more activity increases injury risk but not physical fitness

Modifiable Risk Factors

- Higher fitness levels protect against injuries during Army training
- Subsets of the population exhibit greater but modifiable risks (e.g., lean-low fit, smokers)

Prevention

- Prevention of overtraining can reduce injury risk and improve fitness
- Other strategies (shoe type, stretching, insoles, nutrition) do not show evidence of effect

Next Steps

- Assessment of injury risk factors and interventions among Navy & Air Force active duty
- Further quantification of exposure, relationships with other health conditions, machine learning to predict risk



Questions?



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Additional Material




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Injury Prevention for Active Duty Personnel

Last Updated: November 16, 2023

[DCPH-A Home](#) / [Topics](#) / [Diseases & Conditions](#) / Injury Prevention for Active Duty Personnel




An injury is damage to a body caused by an external energy (e.g., acute or repeated mechanical traumas, environmental, biological, chemical, or electrical sources).

When the damage requires a medical visit, the type of injury is captured in Service Members' electronic medical record (EHR). Military public health experts analyze EHR and report statistics for all injuries organized by type of causal energy source (referred to as the "Taxonomy of Injuries").

- See [Army Annual Injury Surveillance reports](#)

THE FACTS:

- Majority (>2/3) of military injuries are **musculoskeletal OVERUSE INJURIES** (\$billions annually)
- Key fatal and severe injuries in the military are due to **motor vehicles, heat, and cold** weather
- Most common cause of acute injuries (fractures, sprains, strains) is **accidental falls**
- Having certain injuries, such as musculoskeletal injuries to a particular body region, and heat- or cold-weather injuries, may predispose a person to a similar injury or long-term injury-related condition
- See [your installation's data](#)



BENEFITS OF PREVENTING INJURIES:

- Reduce time loss** to physical restrictions for work/training ([temporary profile](#))
- Decrease costs** (direct medical, compensation/disability, & lost duty time)

Articles

Additional References

Selected Army injury prevention scientific journal articles and technical reports.

Army Injuries, Causes, Risk Factors, and Prevention Overview

General Information on Army Injuries, Injury Causes and Risk Factors, and Prevention.

Army Injury Prevention Factsheets and Training Products

Fact sheets and training products regarding types of injuries associated with activities, risk factors, and means to reduce associated injuries

Installation Injury Monitoring Tools

Links for Army injury surveillance definitions, and several reports including: Army Strategic Management System (SMS); Public Health Management System (PHMS); and Health of the Force - Online.

Military Activity Related Injuries

Information pertaining to prevention of injury from military activities, including: Basic and Initial Entry Training; Deployment; Obstacle Courses and Combatives; Parachuting; Physical Fitness Training; Road Marching; and more.

Slip, Trip and Fall Related Injuries

Information on injury prevention related to slips, trips and falls.

Sports and Physical Training Injuries

Injury prevention pertaining to sports and physical training.

Vehicle Accident Injuries

Information pertaining to

Webpage:

<https://ph.health.mil/topics/discond/ptsaip/Pages/default.aspx>



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Education Series

The Military Injury Prevention Research To Practice Work Group presents:
FY24 RESEARCH TO PRACTICE EDUCATION SERIES

“Bringing injury prevention and physical performance science to the field”

Co-leads: Defense Centers for Public Health – Aberdeen Injury Prevention
 & Uniformed Services University Consortium for Health and Military Performance

DECEMBER TOPICS

FIELD TO POLICY: THE SCIENCE BEHIND THE 2023 ARMY BODY COMPOSITION POLICY

Presented by: Katie Taylor, ScD

This presentation will provide an overview of the research that supported the 2023 policy changes to the Army Body Composition program outlined in Army Directive 600-9.

MODERNIZING U.S. MARINE CORPS BODY COMPOSITION STANDARDS

Presented by: Adam Potter, PhD, MBA

This presentation will outline progress and steps towards science-based changes to body composition standards and policies. It will summarize study designs, present main findings to date, and highlight next steps.

7 DEC 2023, 1300-1410 (EASTERN TIME)

[Join Microsoft Teams Meeting](#)

Note: Click hyperlink above, or copy and paste link into Chrome or Edge browser, to launch MS Teams.

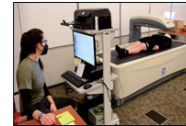
https://dod.teams.microsoft.us/j/199%3adod%3ameeting_c9e228f7b0184f85b738c35c74c08b7540f8read.v2/0?context=767b%221d%22%3a%228903a443-af33-4ed4-af5-ee613bc2f59%22%2c%220fd%22%3a%22e6d8e320-7d56-419d-a539-d025b6fe820a%22%7d

No registration required. Visit the Education Series webpage for more information:

<https://phc.amedd.army.mil/topics/campaigns/amed2020/Pages/Army2020EducationSeries.aspx>

Faculty affiliation:
 U.S. Army Research Institute of Environmental Medicine (ARIEM)

If you have questions, please contact:
usarmy.apg.medcom-aphc.mbx.injuryprevention@health.mil



Webpage: <https://ph.health.mil/topics/campaigns/amed2020/Pages/Army2020EducationSeries.aspx>

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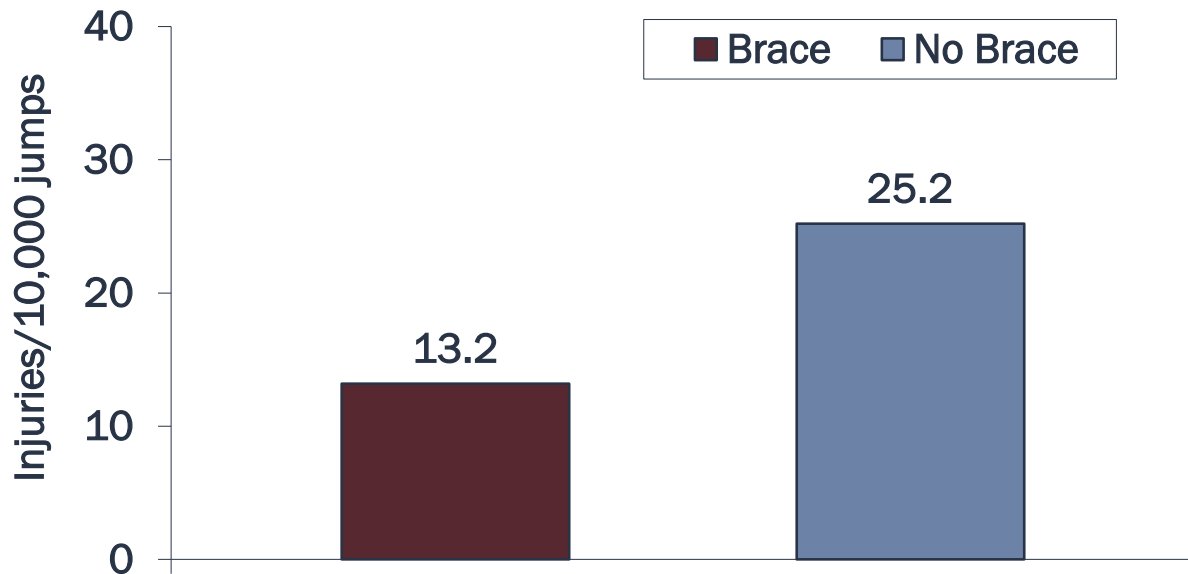
Prevention of Other (Acute) Injuries: Parachuting, Motor Vehicle, Falls



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All Ankle Injuries, Parachute Ankle Brace

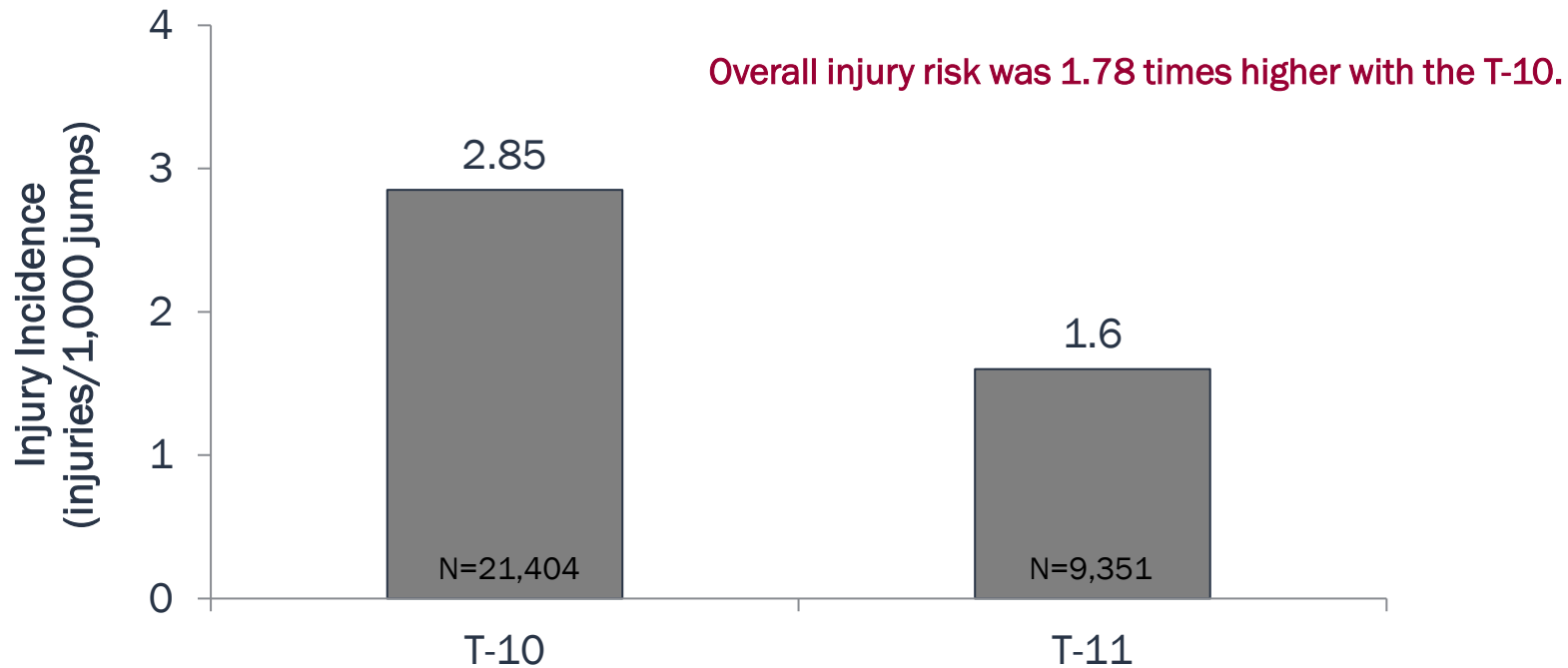


Based on 102,784 jumps, 217 ankle injuries

Risk Ratio (No Brace/Brace)=1.92 (1.38–2.67), $p < 0.01$



T-10 vs. T-11 Injury Incidence at U.S. Army Airborne School (Daytime Jumps)



Source: Knapik J et al. 2011. "The Advanced Tactical Parachute System (T-11): injuries during basic military parachute training," *Aviat Space Environ Med* 82(10):935-40.



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Risk of Fatalities in HMMWV Crashes by Seat Belt Use, OIF/OEF 2004–2005

Seat Belt Use	% Fatalities
No (n = 49)	28.6%
Yes (n = 88)	4.7%
Risk Ratio (RR no/yes) (95% CI); p-value	6.1 (2.1–17.6); p < 0.001

Source: USACHPPM. 2005. EPICON Report 12-MA-03Z8-05, *Risk Factors for HMMWV Accidents*, prepared by Chervak M et al. Aberdeen Proving Ground, MD.



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Risk of Fatalities in Military Vehicle Rollover Crashes by Seat Belt Use, OIF/OEF 2004–2005

Seat Belt Use	% Fatalities
No (n = 77)	29.9%
Yes (n = 71)	9.9%
Risk Ratio (RR no/yes) (95% CI); p-value	3.0 (1.4–6.6); p < 0.002

Source: USACHPPM. 2005. EPICON Report 12-MA-03Z8-05, *Risk Factors for HMMWV Accidents*, prepared by Chervak M et al. Aberdeen Proving Ground, MD.



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Reported Non-Fatal and Fatal Motorcycle Traffic Crash Rates among Active Duty Army Motorcyclists

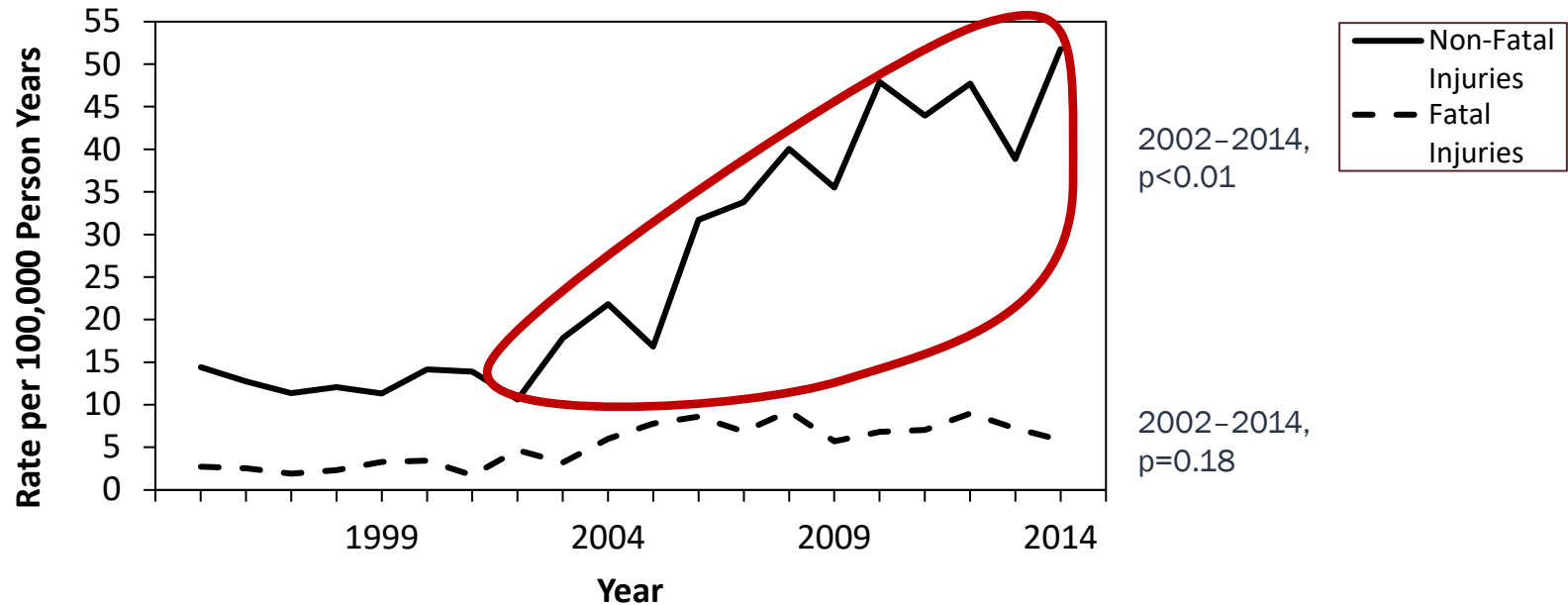


Figure 1. Trends in reported fatal* and non-fatal motorcycle traffic crash rates among Active Duty Army motorcyclists, Army safety reports, 1995–2014 (n=2,852); denominator data from Defense Medical Surveillance System

*Fewer than 20 fatalities per year from 1995 to 2003, except 2002

Source: Rappole C, M Canham-Chervak et al. 2019. *Traffic Inj Prev* 20(2):174–81



Risk Factors for Fatal Motorcycle Crash, Active Duty Army, 1995–2014

Characteristic		Odds Ratio (95% CI)	p-value
Motorcycle Operator Characteristics			
Sex	Male	1.48 (0.72-3.04)	0.28
	Female	1.00	
Rank	Enlisted (E1-E4)	1.14 (0.75-1.73)	0.55
	Enlisted (E5-E9)	1.46 (0.98-2.18)	0.06
	Officer or Warrant Officer	1.00	
Alcohol Use	Yes	3.14 (2.17-4.53)	< 0.01
	No	1.00	
Helmet Use	Yes	1.00	
	No	1.89 (1.24-2.89)	< 0.01
Off Duty	Yes	2.44 (1.28-4.63)	< 0.01
	No	1.00	
Motorcycle License	Yes	1.00	
	No	1.34 (0.94-1.91)	0.11
Hours Slept 24 Hours Prior to Incident	Less than 8 hr sleep	2.30 (1.80-2.92)	< 0.01
	8 hr or more sleep	1.00	
Crash Characteristics			
On an Army installation	Yes	1.00	
	No	2.18 (1.41-3.37)	< 0.01
Period of day	Day	1.00	
	Night	1.20 (0.93-1.53)	0.16
	Twilight	0.60 (0.33-1.09)	0.09
Collided w Vehicle/Object/Person	Yes	2.17 (1.72-2.73)	< 0.01
	No	1.00	

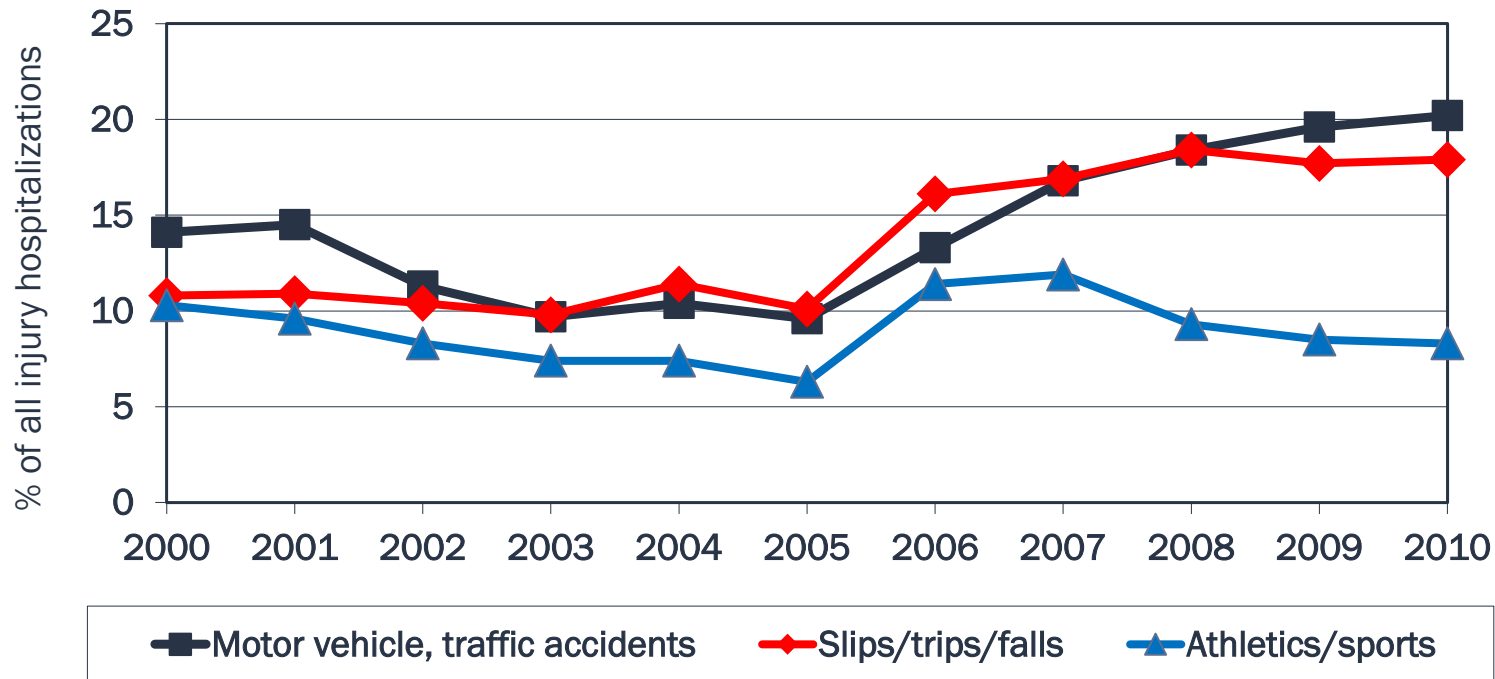
Bold text represents significance at $p \leq 0.05$.

Source: APHC. 2017.
Rappole C. APG, MD.

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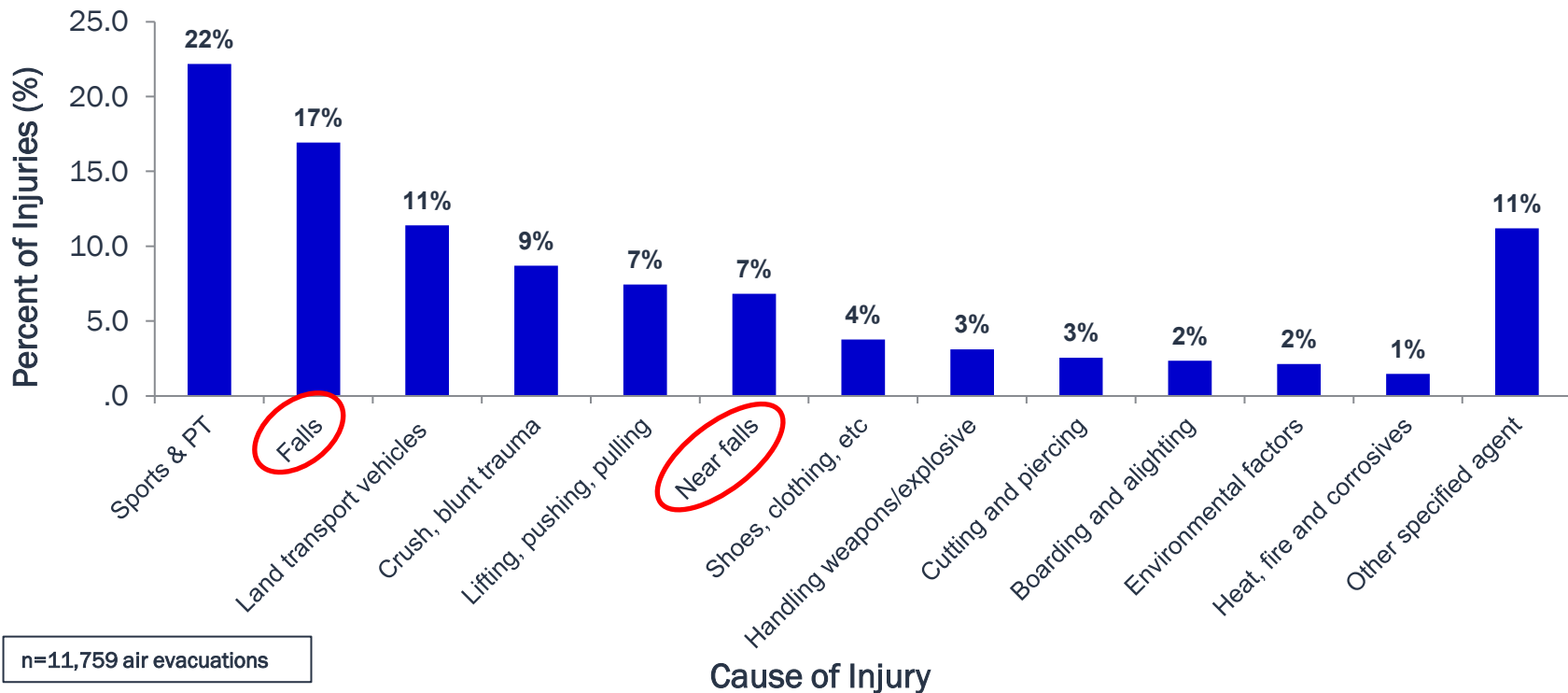
Falls: Leading Cause of Injury Hospitalizations Active Duty Army, 2000–2010



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Falls: Leading Cause of Air-Evacuated Non-Battle Injuries, Iraq and Afghanistan, 2001–2009



Systematic Review: Prevention of Work-Related Falls

- Ten interventions, 1970–2010
- Overall mean quality score: 6.4 out of 10 (range: 4.0–8.0)
- Types of interventions:
 - Pre-/post-occupational regulation changes (3)
 - Fall prevention education and management tools (3)
 - Fall prevention physical/environmental changes (2)
 - Fall prevention clinic for at-risk population (1)
 - Fall prevention community intervention (1)

Source: Canham-Chervak M et al. 2015. "Identification of fall prevention strategies for the military: a review of the literature." *Mil Med* 180(12):1225–32.

