Military Injuries: A Review of the Epidemiology and Science

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

Public Health Approach to Injury Prevention

Five Key Public Health Questions	Five Steps of the Public Health Approach
1. Is there a problem, and how big is it?	1. Surveillance
2. What causes the problem?	2. Research and field investigations
3. What works to prevent the problem?	3. Intervention trials and systematic reviews
4. Who needs to know and do what?	4. Program and policy implementation
5. How effective is what we have done?	5. Program evaluations and monitoring

Resembles the Risk Management Approach:

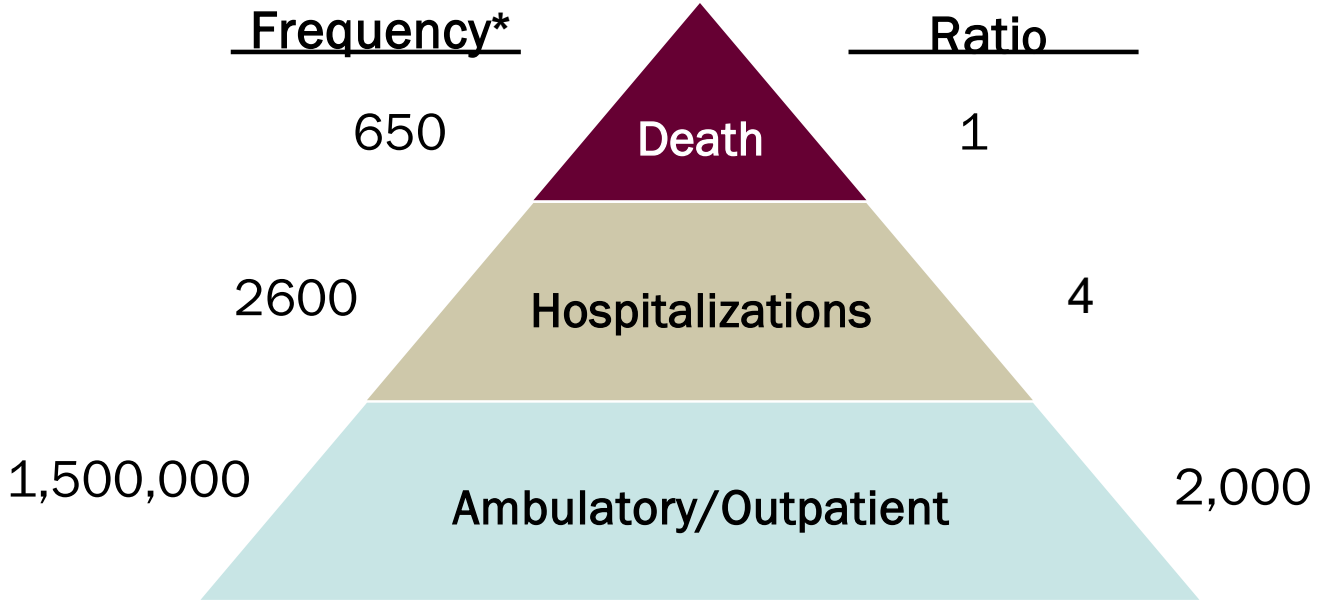
1. Identify hazards
2. Assess hazards
3. Develop controls and make decisions
4. Implement controls
5. Supervise and evaluate

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.

How big is the problem?
Lessons from Injury Surveillance/Monitoring

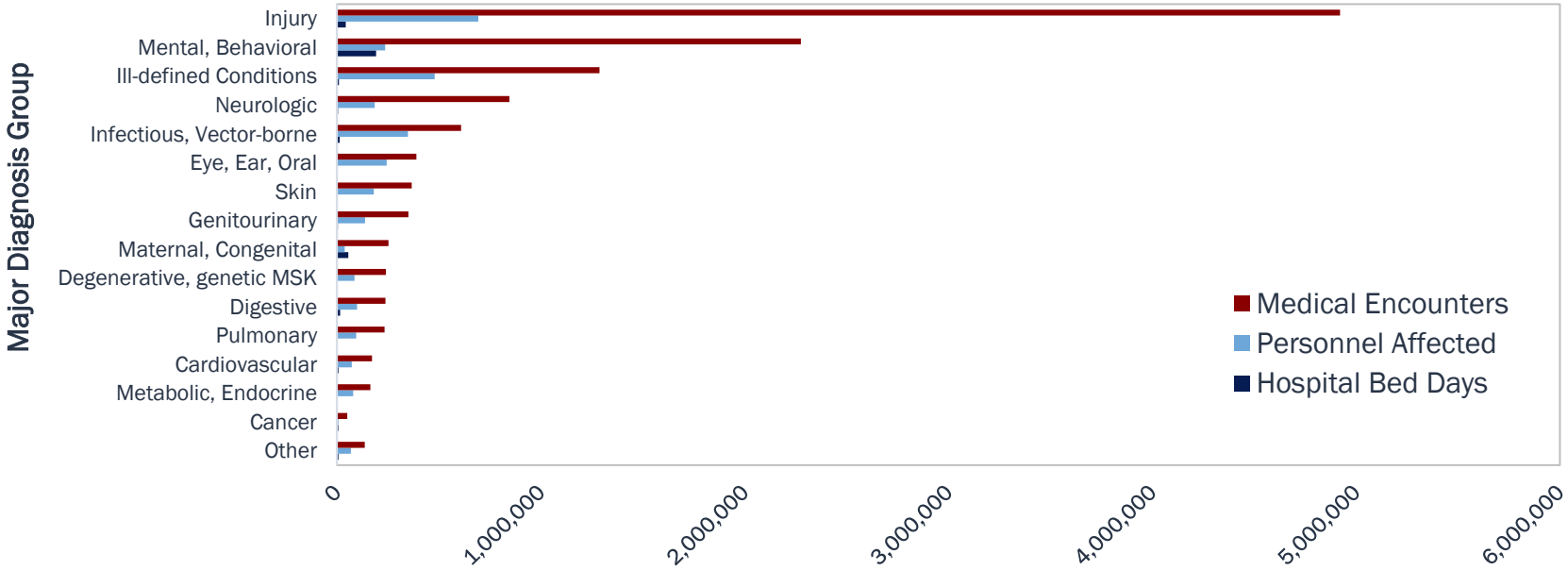


Injury Pyramid
U.S. All Services Active Duty, 2021



*Frequencies are rounded and represent incident injury visits

Relative Burden of Illnesses and Injuries
U.S. All Services Active Duty, 2021



*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).

Taxonomy Distribution of Injuries
U.S. All Services Active Duty, 2021

Incident Injuries, N = 1,480,911

Mechanical Energy Injuries
n= 1,419,616 (96%)

- **Acute Trauma** n=315,666 (21%)
  - MSK n=171,812 (12%)
  - Non-MSK n=143,854 (10%)
- **Cumulative Microtrauma** n=1,103,950 (75%)
  - MSK n=1,016,618 (69%)
  - Non-MSK n=87,332 (6%)

Non-Mechanical Energy Injuries
n= 29,346 (2%)

- **Environmental** n=6,122 (<1%)
  - Heat & Sun n=5,026 (<1%)
  - Cold n=620 (<1%)
  - Altitude/ Pressure n=469 (<1%)
  - Lightning n=7 (<1%)
- **Poisons** n=19,213 (1%)
  - Drugs n=2,916 (<1%)
  - Toxins n=2,250 (<1%)
  - Chemicals n=14,047 (<1%)
- **Non-Environmental** n=4,011 (<1%)
  - Thermal Burns n=3,647 (<1%)
  - Electrical n=343 (<1%)
  - Nuclear Radiation n=21 (<1%)

Other/Unspecified Injuries
n= 31,949 (2%)

- **Medical Complications** n=13,169 (<1%)
  - Other Reaction to External Cause n=3,187 (<1%)
  - Foreign Body n=967 (<1%)
  - Medical Accidents n=75 (<1%)
- **Abuse/ Intentional** n=5,866 (<1%)
  - Unspecified/ Multiple Injuries n=8,301 (<1%)
  - Lack of Essential Element n=384 (<1%)

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

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	

Causes of Injury Temporary Profiles & 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)
- *Lifting*	240,001	(3.5)	61,789	(3.0)	301,790	(3.4)
- *Mechanical/repair*	60,776	(0.9)	8,165	(0.4)	68,941	(0.8)
- *Pushing or pulling objects*	28,363	(0.4)	6,795	(0.3)	35,158	(0.4)
- *Work tasks, other*	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)

Public Health Approach to Injury Prevention

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5. How effective is what we have done? →	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.

What causes the problem?
Lessons Learned from Surveillance Data, Surveys, and Epidemiologic Investigations



Self-Reported, Injury-Related Limited Duty (Temporary Profiles) by Activity, U.S. Army Infantry Units

Activity associated with injury	Total injuries n (% injuries, n=874)	Medical visit with temporary profile n (% total profiled, n=529)	Total limited duty days n (% total days, n=19,628)	Avg limited duty days n (SD)*
Running	275 (31.5)	163 (30.8)	5,844 (29.8)	38 (38)
Lifting or moving heavy objects	109 (12.5)	67 (12.7)	1,992 (10.1)	34 (35)
Walking, hiking, or road marching	98 (11.2)	58 (11.0)	2,112 (10.8)	40 (43)
Sports and recreation	85 (9.7)	45 (8.5)	1,637 (8.3)	42 (35)
Physical training, not running	71 (8.1)	41 (7.8)	1,411 (7.2)	35 (40)
Military tasks and training	42 (4.8)	34 (6.4)	1,423 (7.2)	43 (47)
Stepping or climbing (stairs, ladder)	39 (4.5)	31 (5.9)	1,153 (5.9)	37 (27)
Repairing or maintaining equipment or vehicles	24 (2.7)	17 (3.2)	674 (3.4)	40 (47)
Riding or driving in or on a motorized vehicle	19 (2.2)	16 (3.0)	637 (3.2)	42 (36)
Other	63 (7.2)	40 (7.6)	1,988 (10.1)	51 (51)
Unspecified	49 (5.6)	17 (3.2)	759 (3.9)	n/a

Infantry Soldier surveys (n=5,102)

Source: Canham-Chervak M et al. 2018. *US Army Med Dept J* Jul-Dec(2-18):6–13.

* Standard deviation

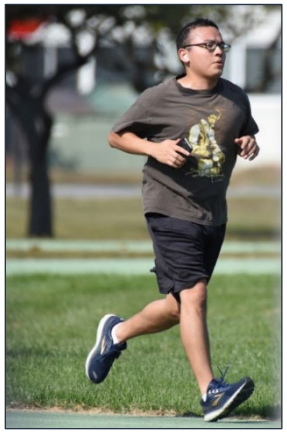
Self-Reported Leading Activities Associated with Injury Survey of Active Duty Service Members

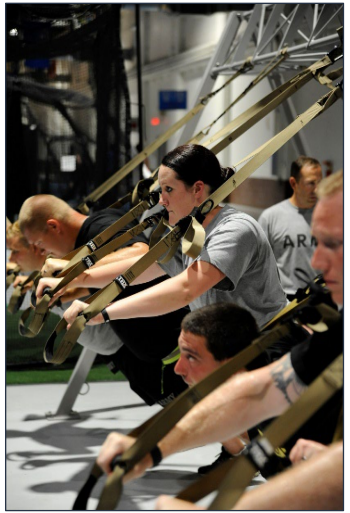
Sports, Exercise, or Recreational Activity	Army n=125,684 Percent	Navy n=57,502 Percent	Marine Corps n=51,745 Percent	Air Force n=63,390 Percent	Total n=298,320 Percent
Running or jogging (outdoors)	50.3	33.2	50.6	41.3	45.1
Weight training	6.4	8.9	6.6	9.6	7.6
Basketball	7.3	10.1	3.5	8.6	7.5
Touch or 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.

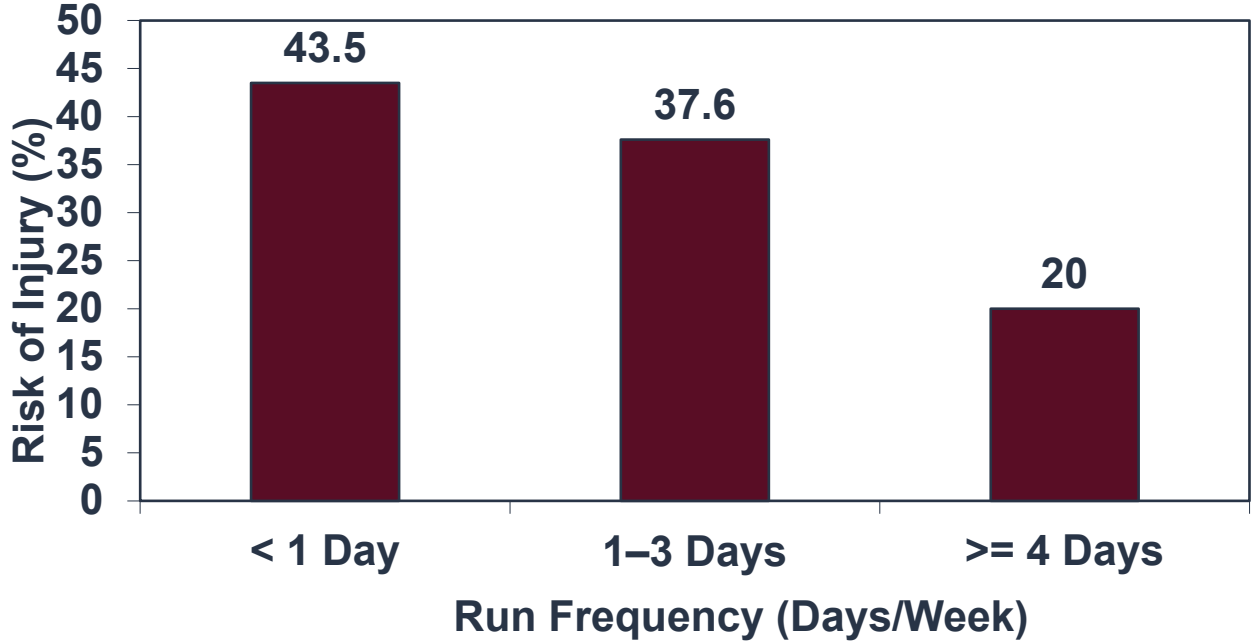
Factors Affecting Risks of Training-Related Injury

- 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)
$RR_{0\text{-}1\ days/>4\ day}$ =2.2, 95% CI: 1.2-4.1

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

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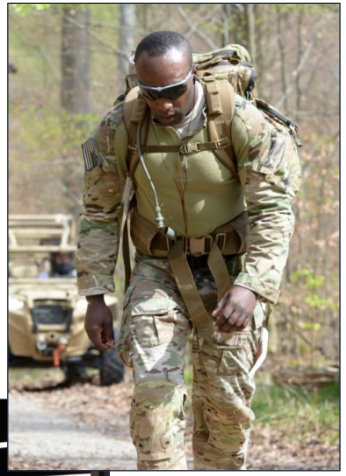
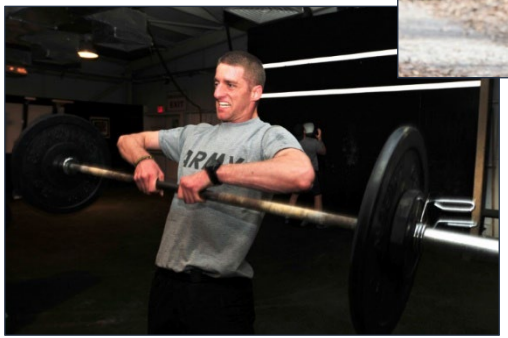
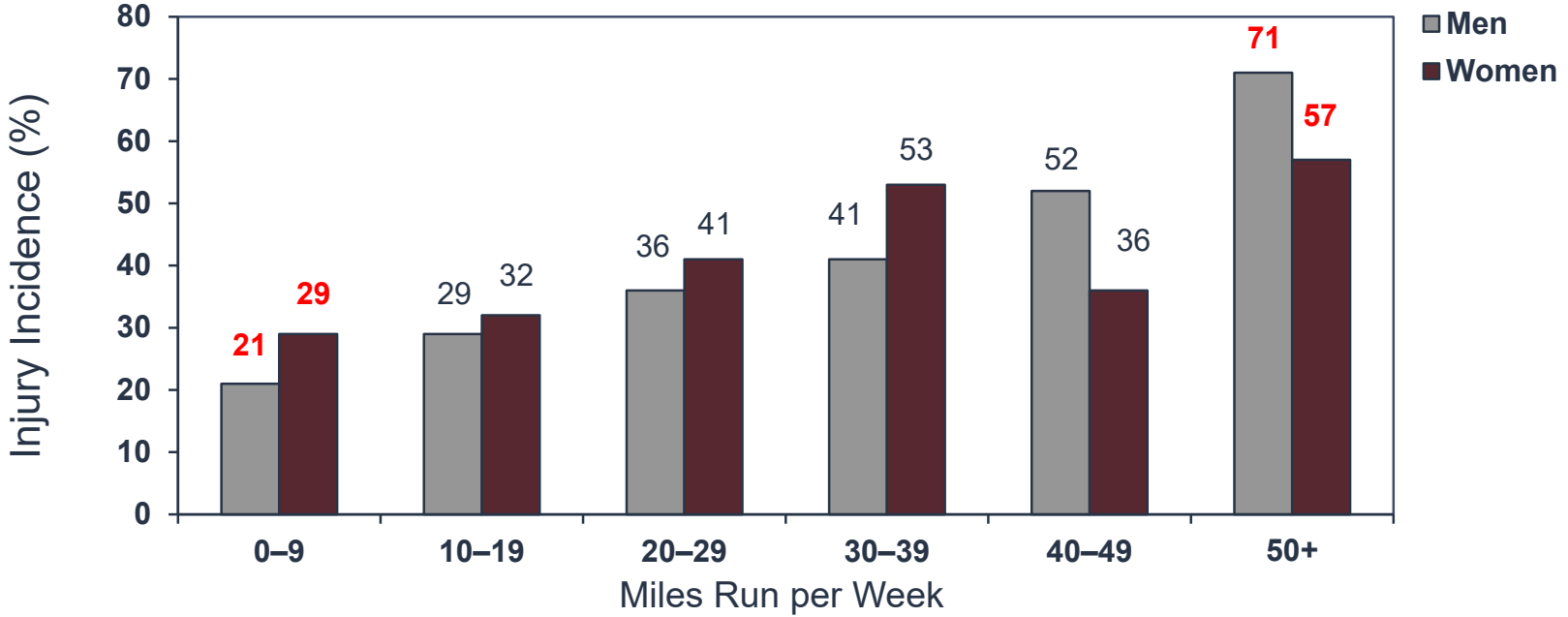




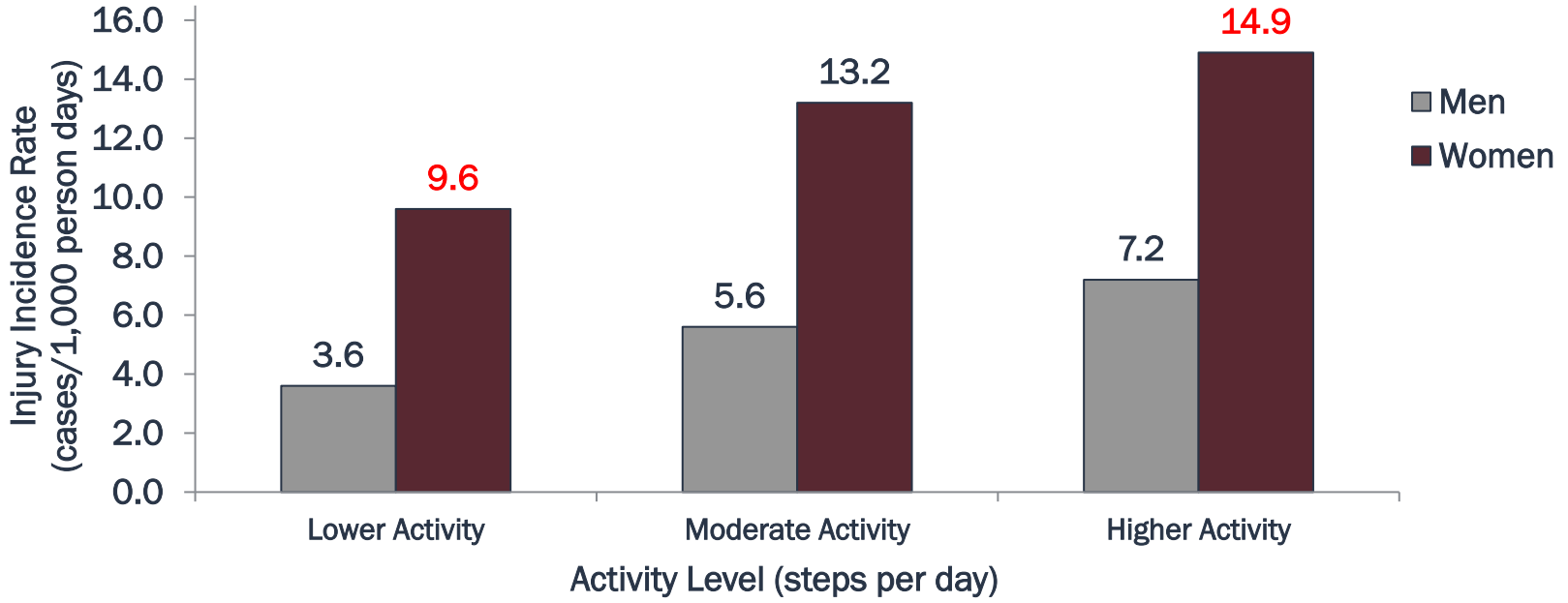
Injuries per Year by Miles Run per Week, Civilian Runners



Race registrants N=1,423 (Men=693, Women=730)
0–9 miles vs 50+ miles: Men RR=3.3 (p<0.001); Women RR=1.8 (p<0.05)
10–19 miles vs 50+ miles: Men RR=2.3 (p<0.001); Women RR=1.8 (p<0.05)

Source:
Koplan JP, KE Powell, and RK Sikes. 1982. *JAMA* 248:3118
Jones BH et al. 1994. *Sports Med* 18(3):202–14

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.

High and Low 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

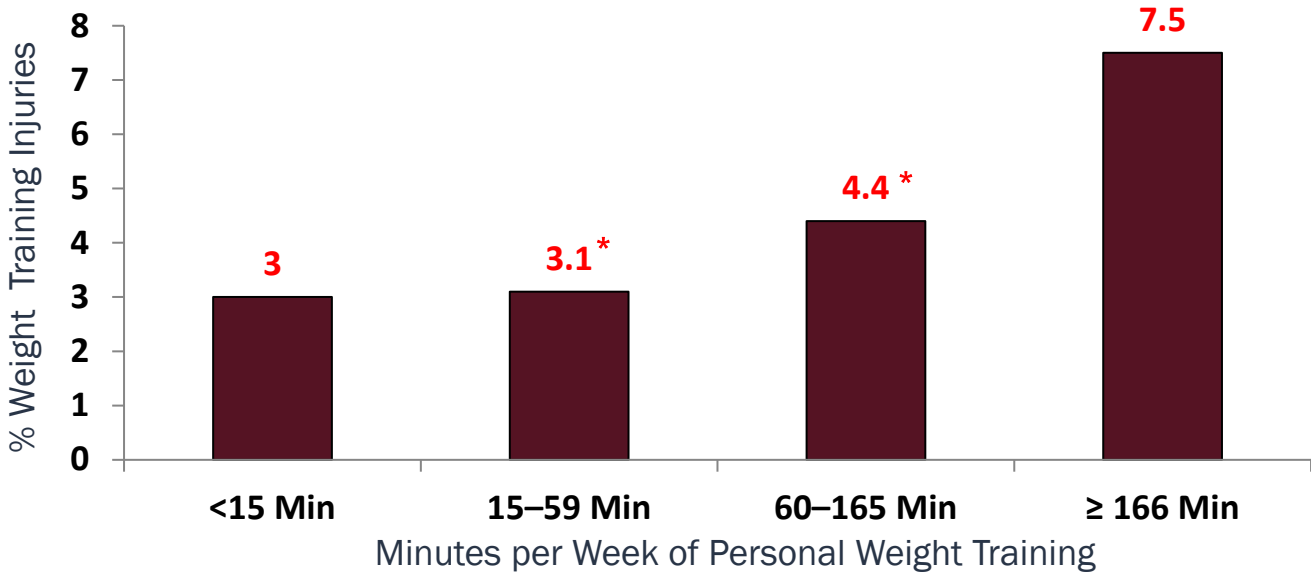
Injury Rate Associated with Road Marching Mileage, U.S. Army Infantry Brigade

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.

Risk of Weight Training Injury by Frequency of Weight Training among 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.

Factors Affecting Risks of Training-Related Injury

- Amount of past physical activity
- Amount of current physical activity
- **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 *per 10,000 miles*	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.

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

Military Training Activity	Rate *per 1,000 person-hours*	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.

Factors Affecting Risks of Training-Related Injury

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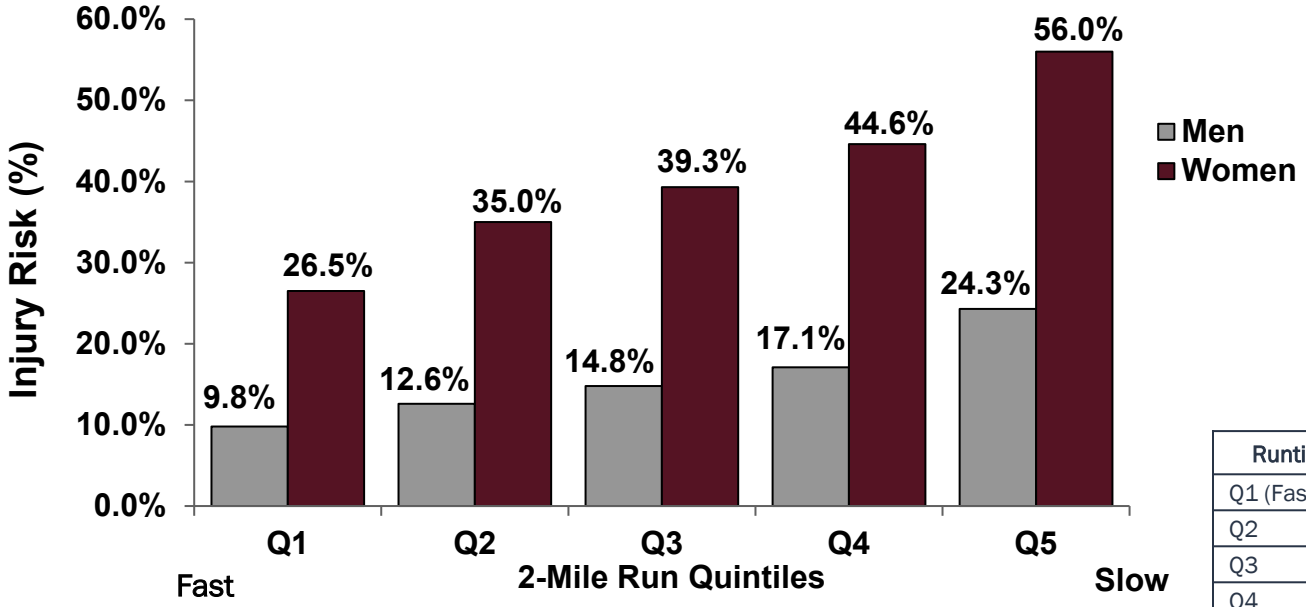
Aerobic Endurance 2-Mile Run Times and Injury Risk for Men and Women in Basic Combat Training

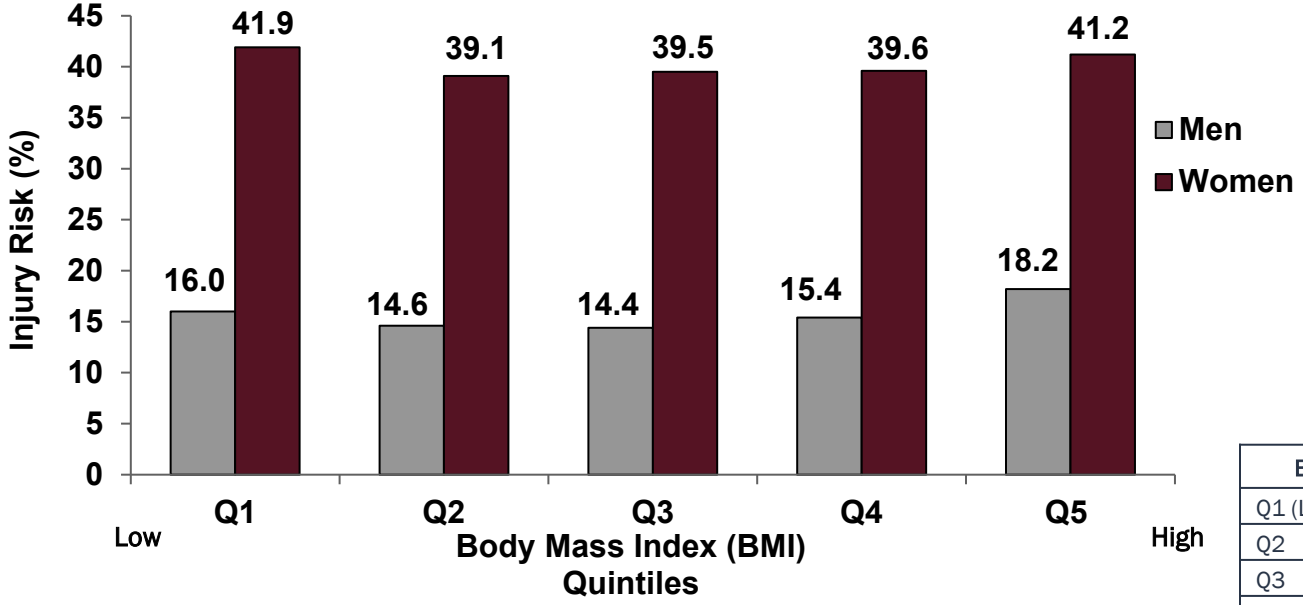


Runtime	Men	Women
Q1 (Fastest)	<13.5	<16.2
Q2	13.5–14.2	16.2–17.3
Q3	14.3–15.0	17.4–18.1
Q4	15.1–15.8	18.2–19.0
Q5 (Slowest)	>15.8	>19.0

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

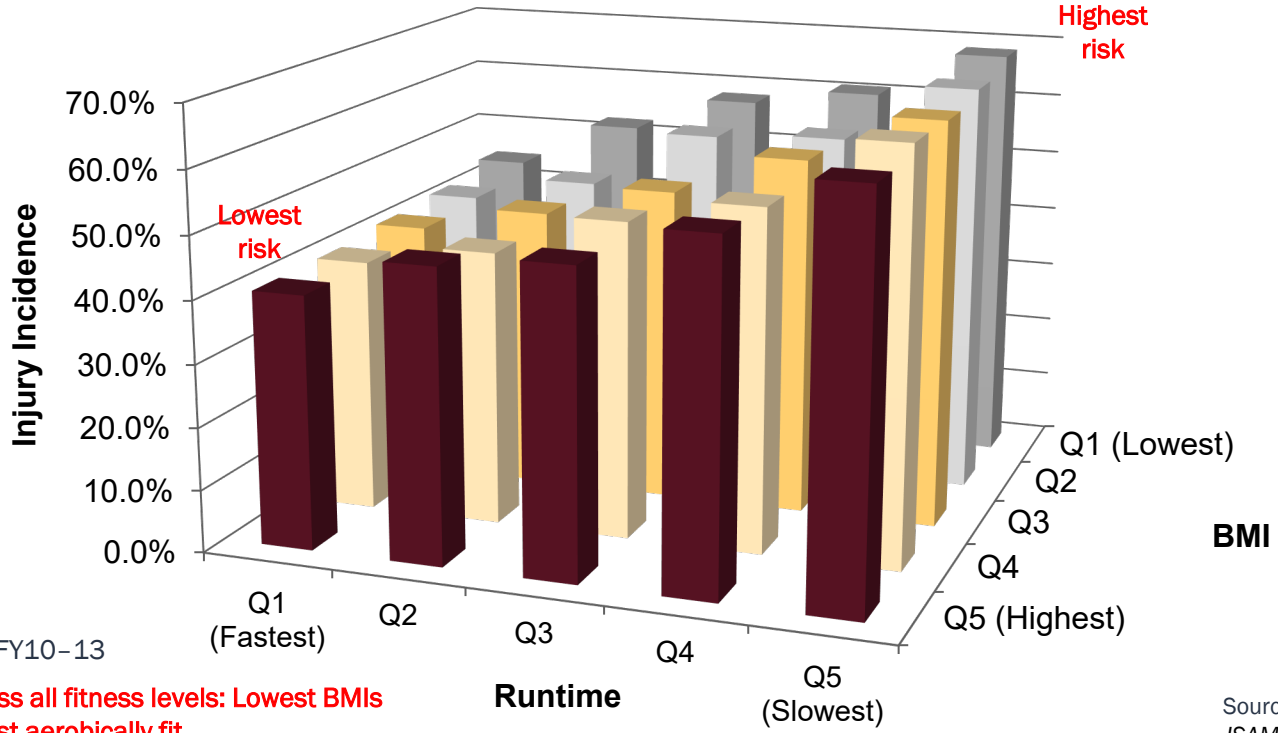


n=184,598 (Men=143,159, Women=41,439)
RR, Q1 vs Q5: Men (1.1, p<0.001), Women (1.0, p=0.36)
RR, Q1 vs Q3: Men (1.1, p<0.001), Women (1.1, p<0.05)
RR, Q5 vs Q3: Men (1.3, p<0.001), Women (1.1, p<0.05)

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

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

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

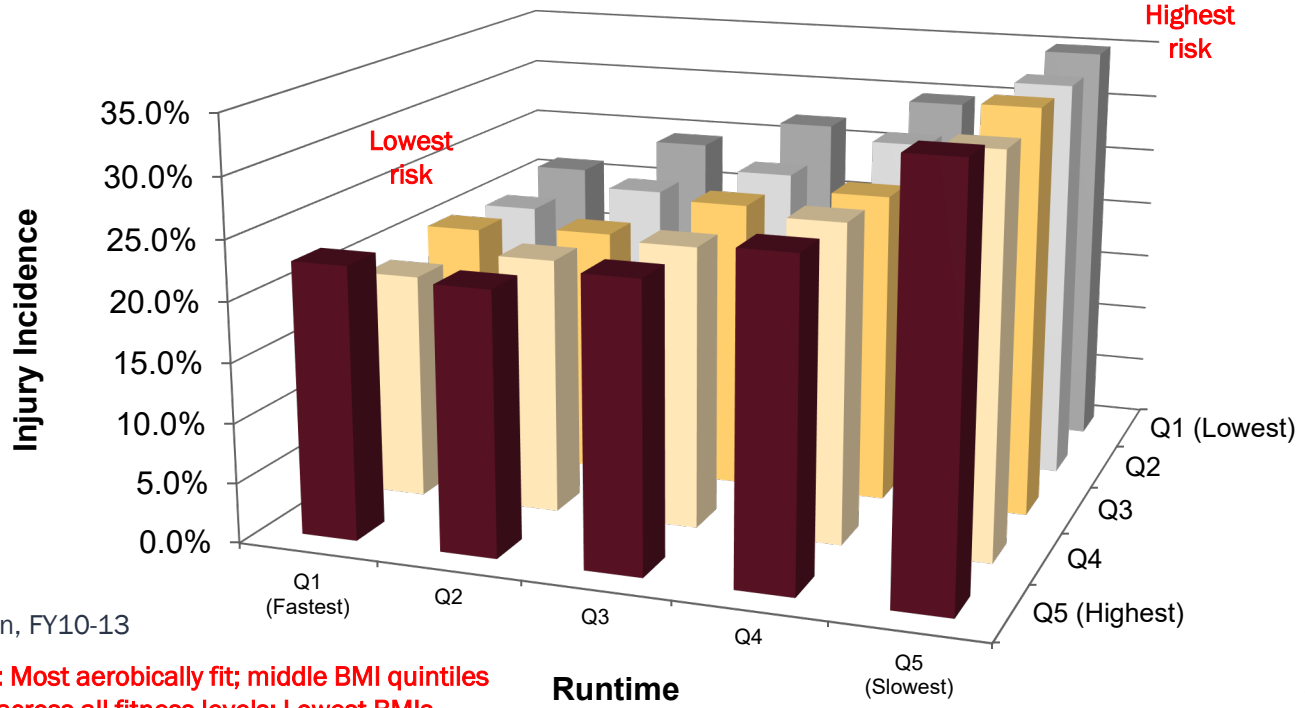


34,931 women, FY10–13

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.

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

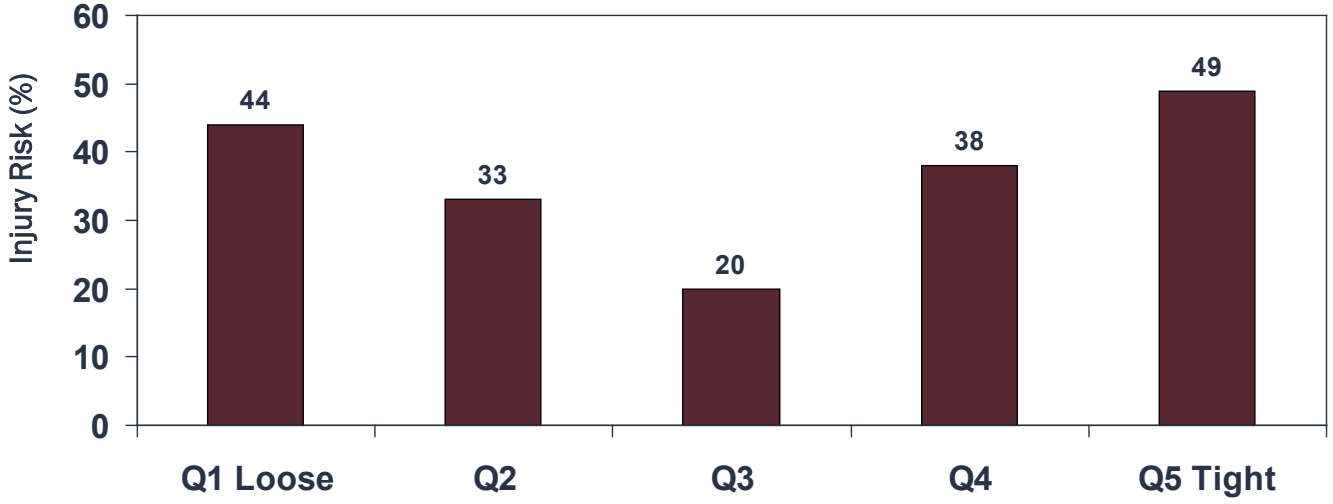


136,797 men, FY10-13

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.

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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- Type of current activity
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Age and Injury Risk

- 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.
- 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.*

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

[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

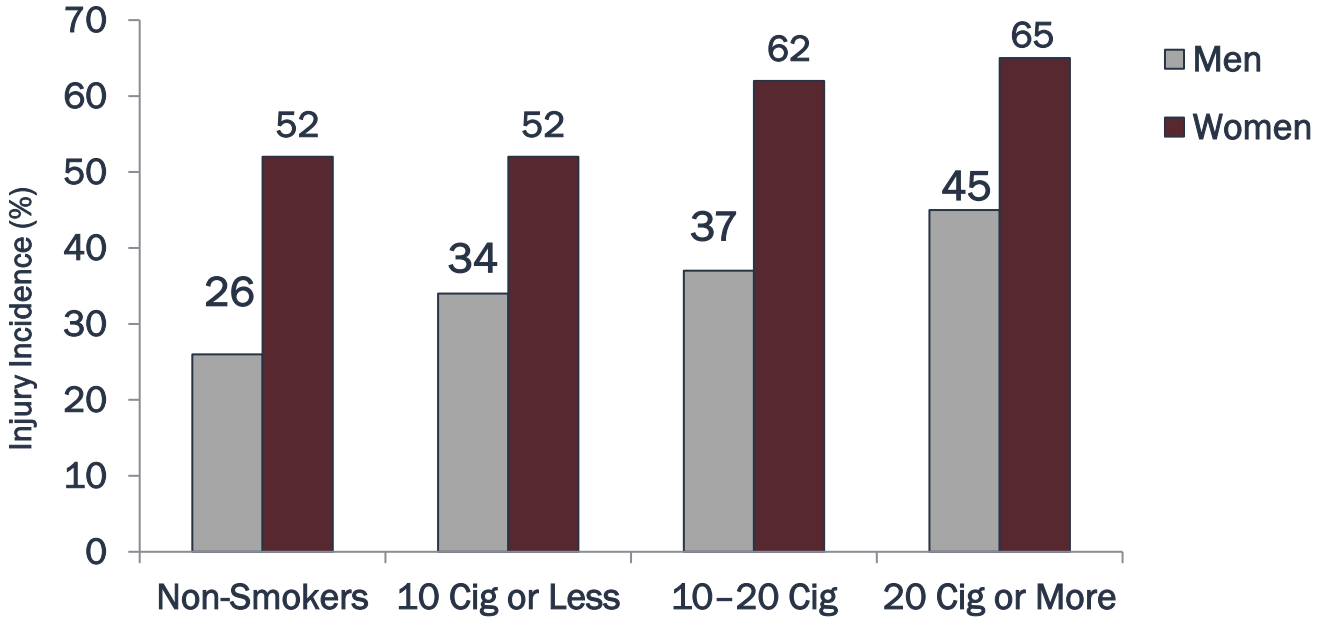
* Rate Ratio (W:M) is statistically significant ($p<0.05$) for the functional category

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%

Behavioral Risk Factors

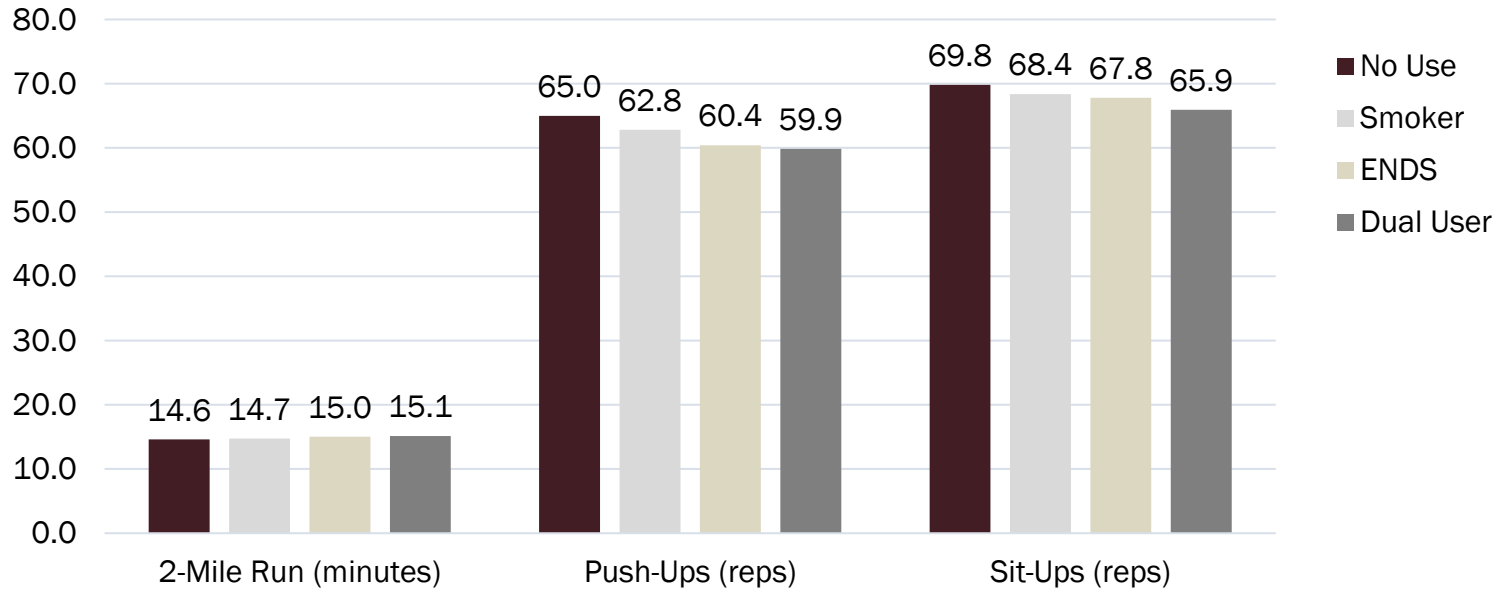
Cigarette Smoking and Injury in Basic Training



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.

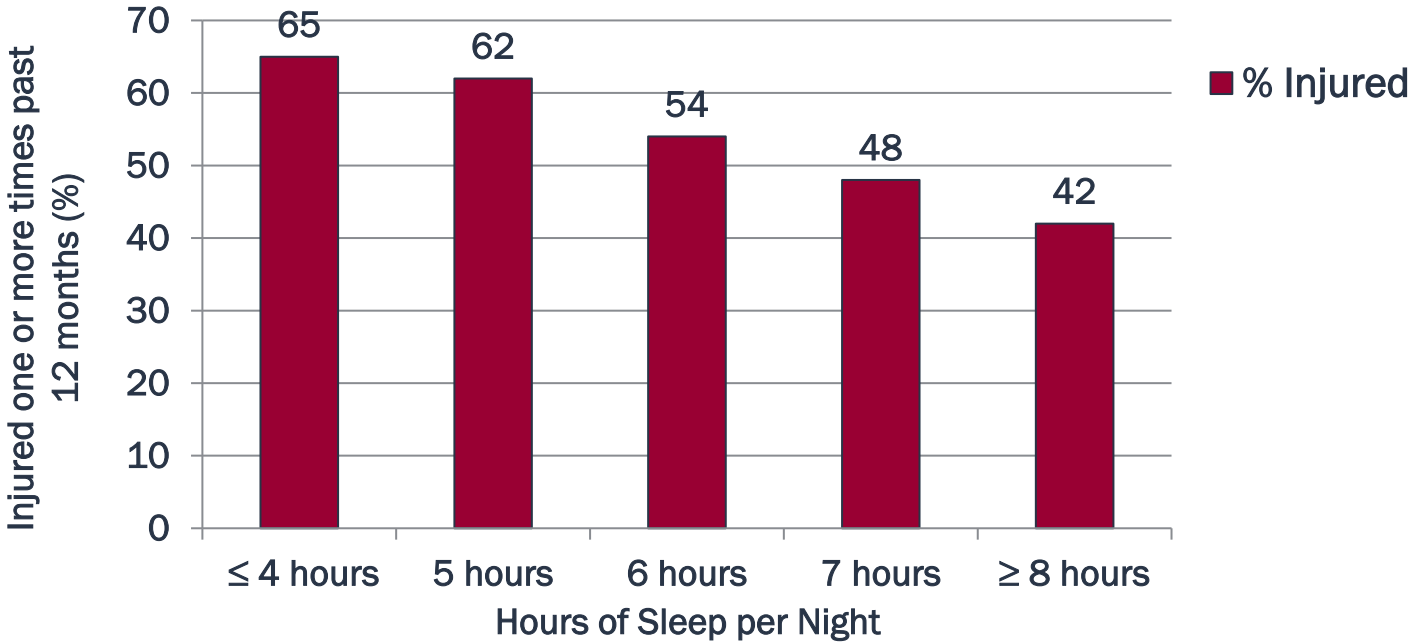
Tobacco Use and Physical Performance on the Army Physical Fitness Test



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.

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	Five Steps of the Public Health Approach
1. Is there a problem, and how big is it? →	1. Surveillance
2. What causes the problem? →	2. Research and field investigations
3. What works to prevent the problem? →	3. Intervention trials and systematic reviews
4. Who needs to know and do what? →	4. Program and policy implementation
5. How effective is what we have done? →	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.

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

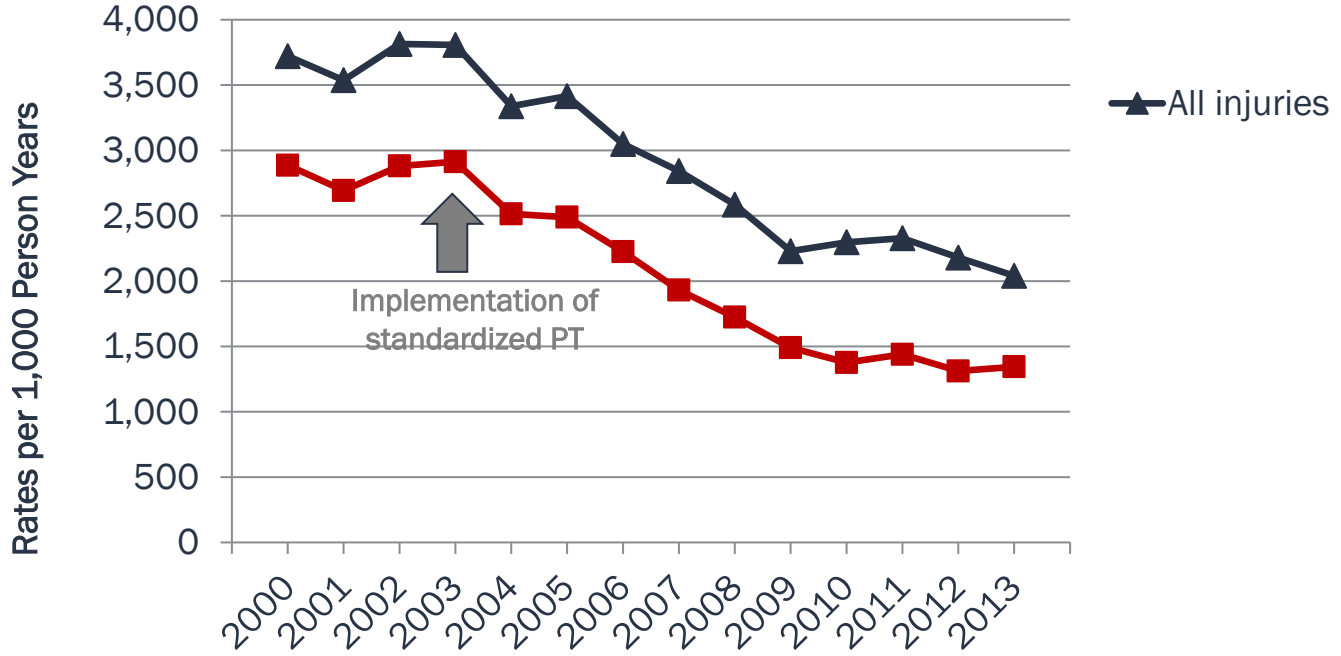
	Traditional PT*	Standardized New PT*	Rate Ratio (95% CI)
Injury Rate (n/100)	31.3%	21.8%	1.4[a] (1.1-1.7)
APFT % Passing	84.4%	88.4%	0.9[b] (0.8-1.0)
% Attrition	7.0%	6.0%	1.2[c] (0.7-1.6)

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

Foot Type and Shoe Type

Foot Type and Shoe Type

ILLUSTRATIONS BY CHARLIE LAYTON

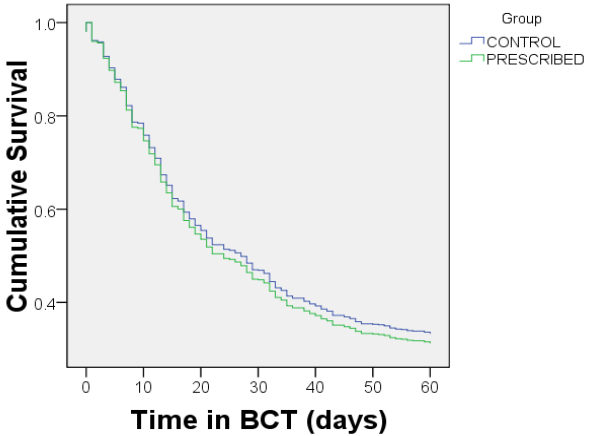
FLAT (LOW) ARCH

NORMAL (MEDIUM) ARCH

HIGH ARCH

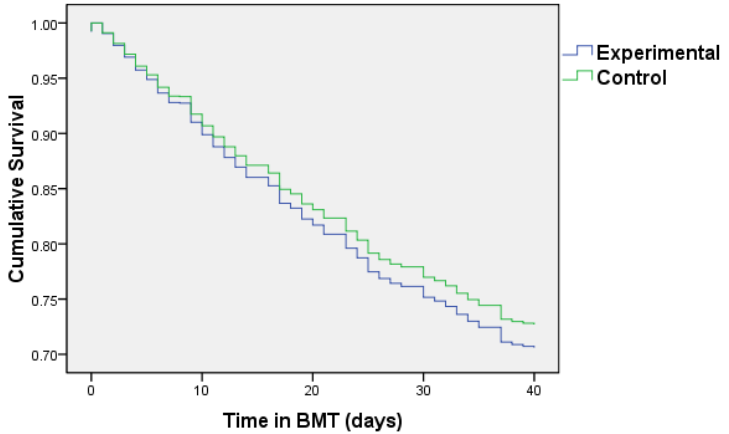
Effect on Injuries of Assigning Running Shoes Based on Foot Arch Height

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; Dijksma 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.

Public Health Approach to Injury Prevention

Five Key Public Health Questions	Five Steps of the Public Health Approach
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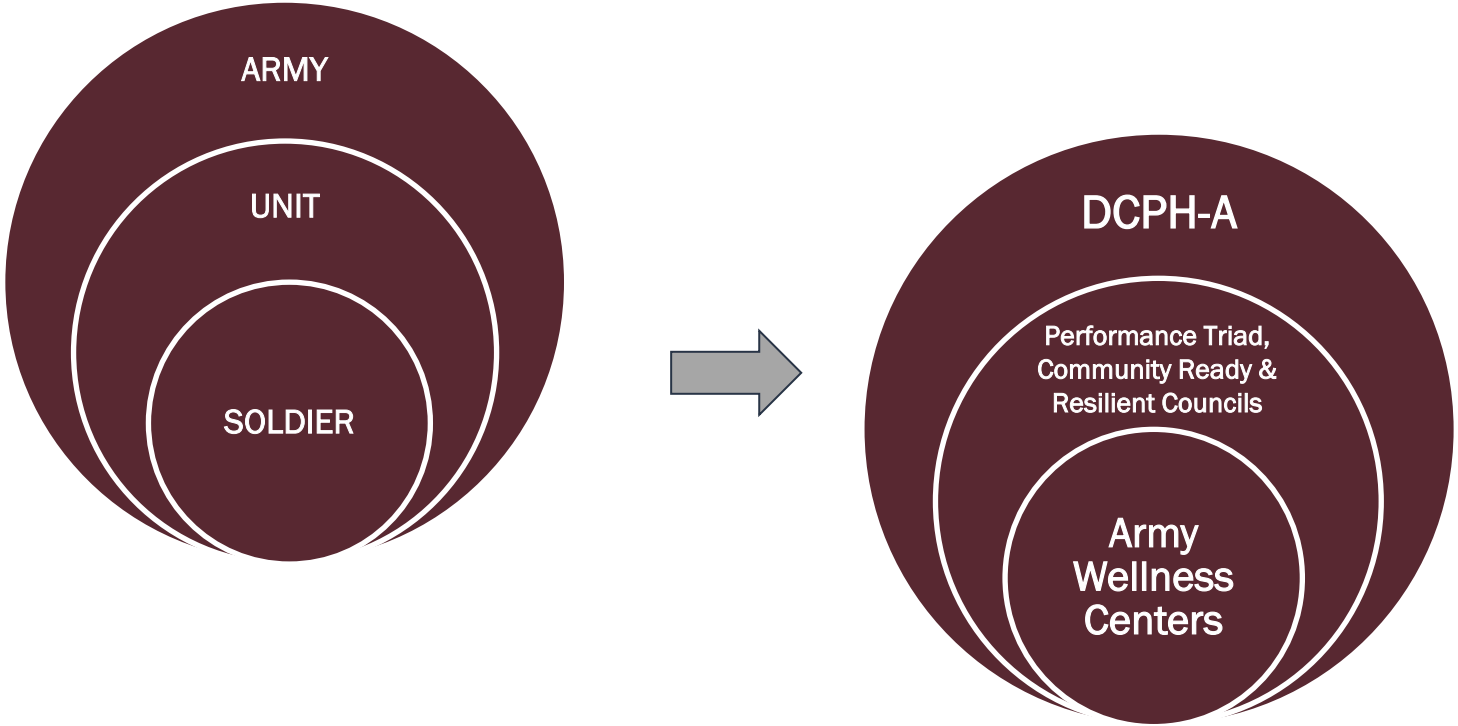
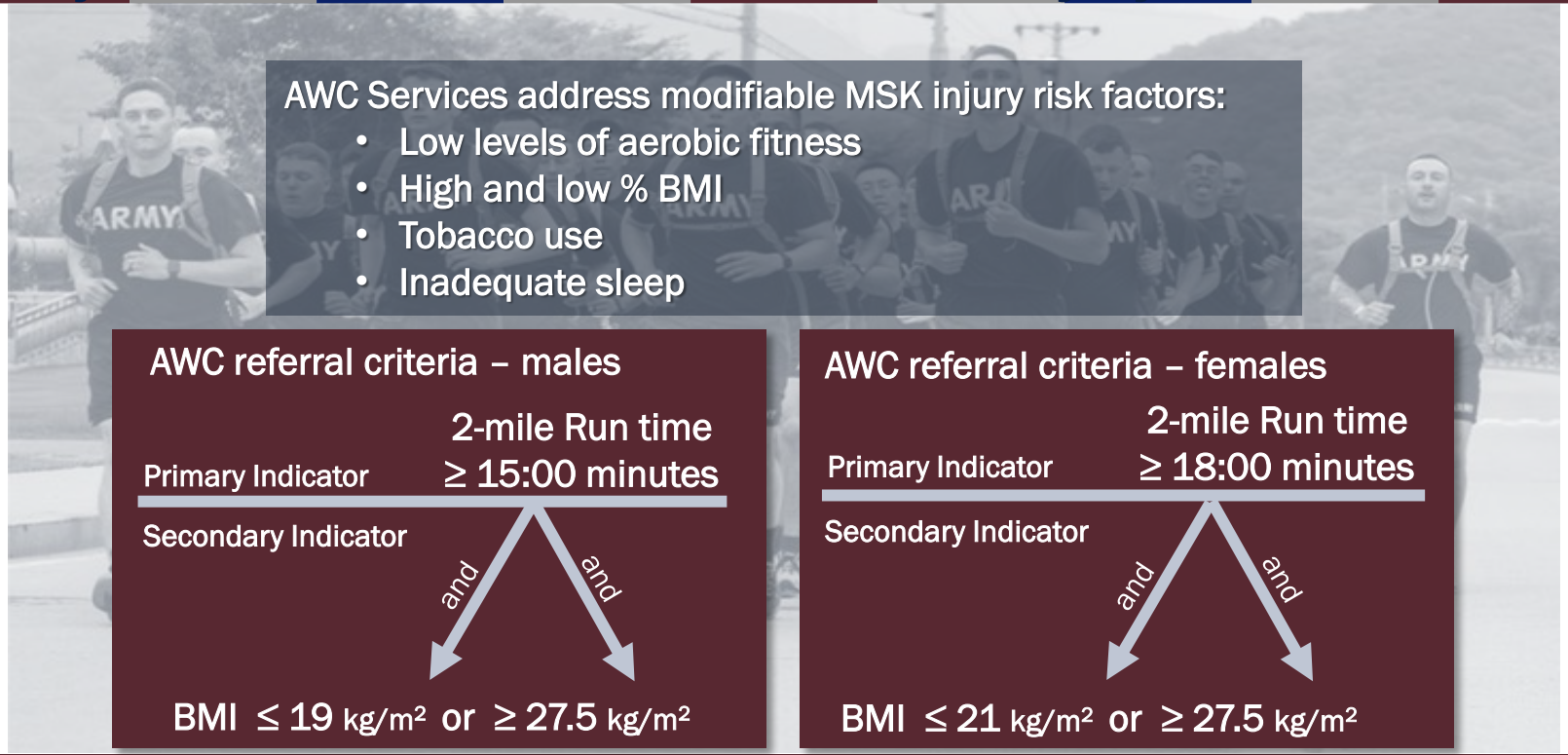
5. How effective is what we have done?	5. Program evaluations and monitoring

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.

Multi-Level Prevention Efforts



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 ≥ 15:00 minutes

Secondary Indicator: BMI ≤ 19 kg/m² or ≥ 27.5 kg/m²

AWC referral criteria – females

Primary Indicator: 2-mile Run time ≥ 18:00 minutes

Secondary Indicator: BMI ≤ 21 kg/m² or ≥ 27.5 kg/m²

Public Health Approach to Injury Prevention

Five Key Public Health Questions	Five Steps of the Public Health Approach
1. Is there a problem, and how big is it?	1. Surveillance
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3. What works to prevent the problem?	3. Intervention trials and systematic reviews
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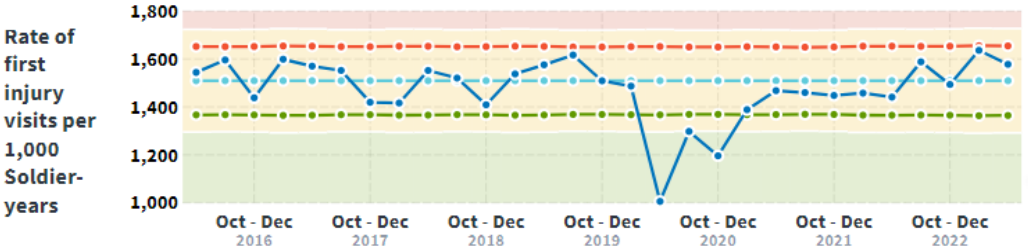
Sources:
Jones BH, VD Hauschild, and M Canham-Chervak. 2018. *J Med Sci Sport* 21(112):1139–46.
Jones BH, DM Perrotta, M Canham-Chervak et al. 2000. *Am J Prev Med* 18(3S):71–84.

Statistical Process Control Charts for Monitoring Injuries

Maintained in the Army Strategic Management System: https://www.sms.army.mil/

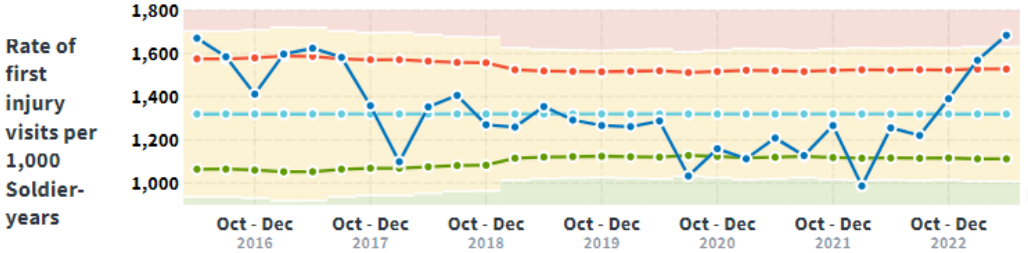
All-Army injury rates



1,578

Latest Quarter Rates	
Numerator:	168,311
Denominator:	106,662.23

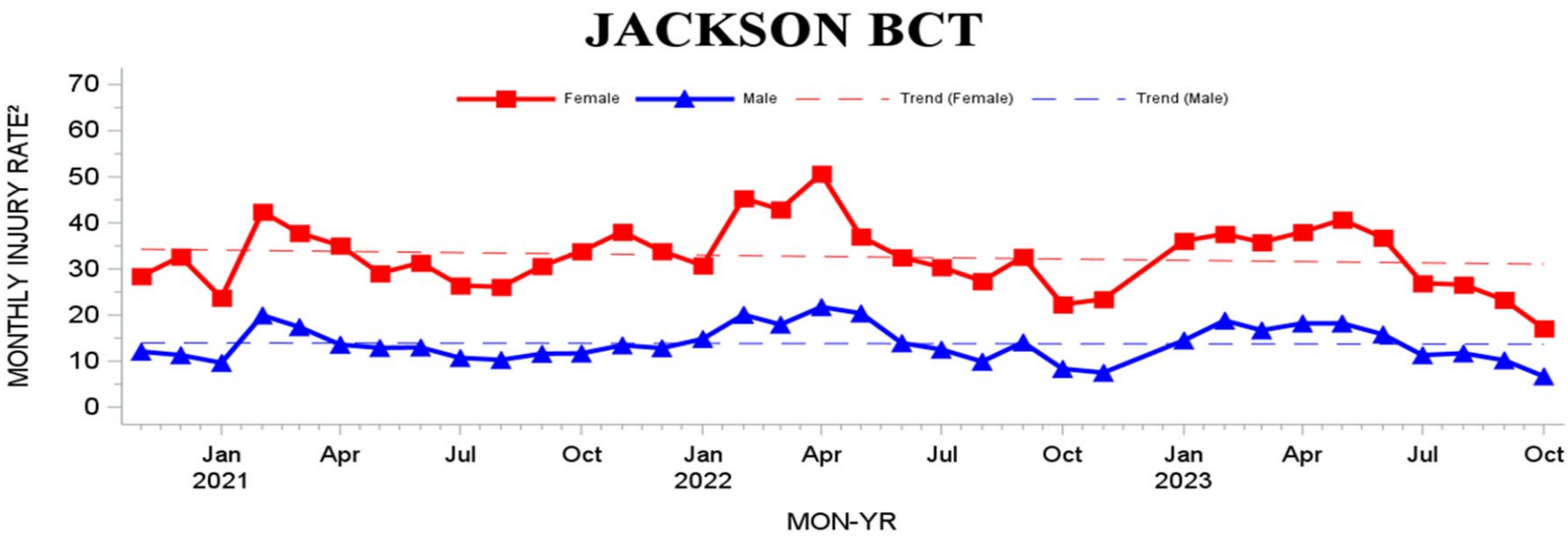
Installation X injury rates



1,684

Latest Quarter Rates	
Numerator:	1,215
Denominator:	721.6

Monthly Training-Related Injury Reports
Army Initial Entry Training, November 2020 to October 2023



[1]Training-related injury: traumatic and overuse musculoskeletal injuries of the low back, pelvis, and lower extremities
[2]Injury Rate: injuries per 100 persons per month
[3]Installation transitioned to MHS Genesis on: 09SEP2022
Prepared by the Armed Forces Health Surveillance Branch, Defense Health Agency and the Injury Prevention Program, Army Public Health Center
Source: Defense Medical Surveillance System (DMSS), NOV2023

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

Physical activity is the leading cause of injuries for the Army.

- Greater amounts increase injury risk
- Consider type and total exposure
- Thresholds exist above which more activity increases injury risk but not 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

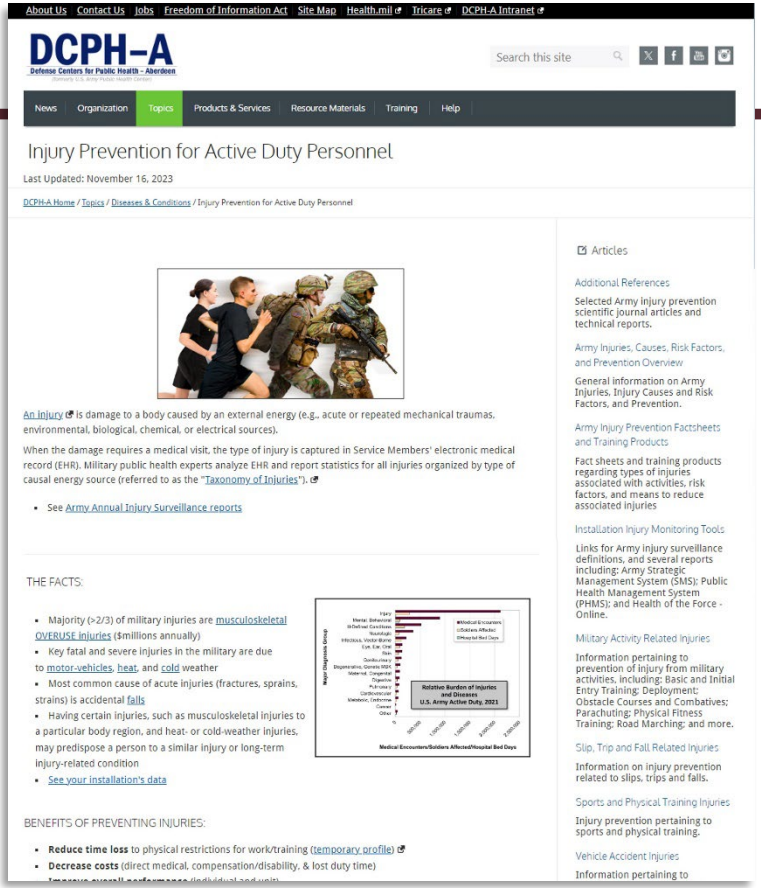
- Communication of lessons learned
- Further quantification of exposure, relationships with other health conditions, machine learning to predict risk

Questions?

Additional Material

Website and Fact Sheets

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



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

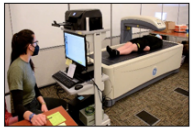
DECEMBER TOPICS

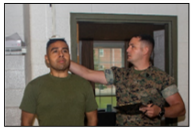
FIELD TO POLICY: THE SCIENCE BEHIND THE 2023 ARMY BODY COMPOSITION POLICY
Presented by: Katie Taylor, ScD

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/l/meetup-join/19%3adod%3ameeting_c9e228f7b0184f85b738c35c3e74c08b%40thread.v2/0?context=%7b%22Tid%22%3a%228903a443-af33-4ed4-acf5-ee613bcb2f59%22%2c%22Oid%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

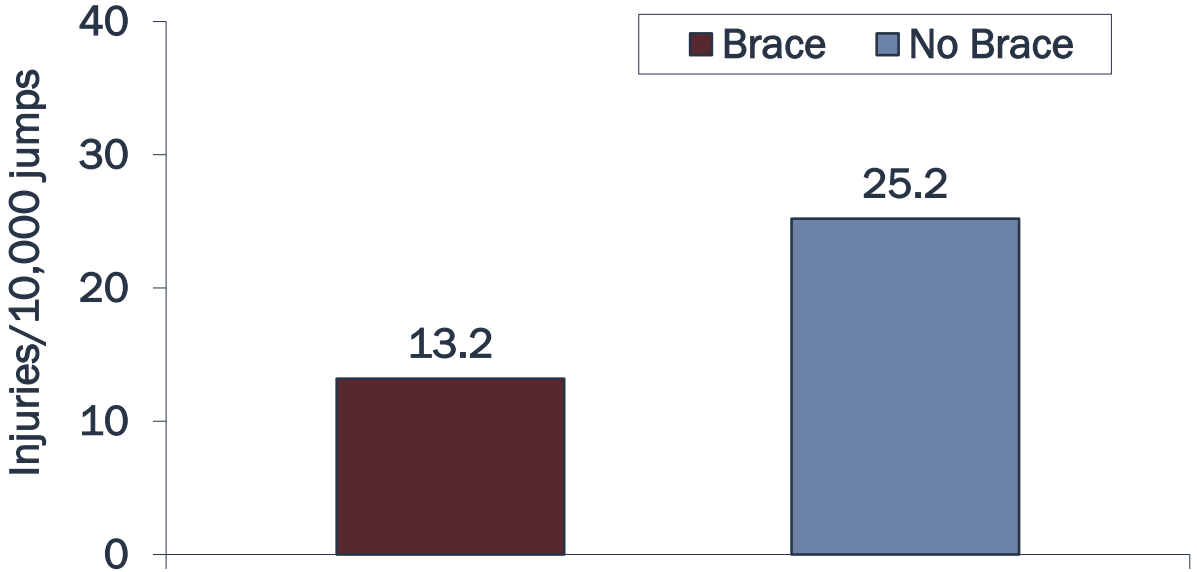
Faculty affiliation:
U.S. Army Research Institute of Environmental Medicine (ARIEM)

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

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

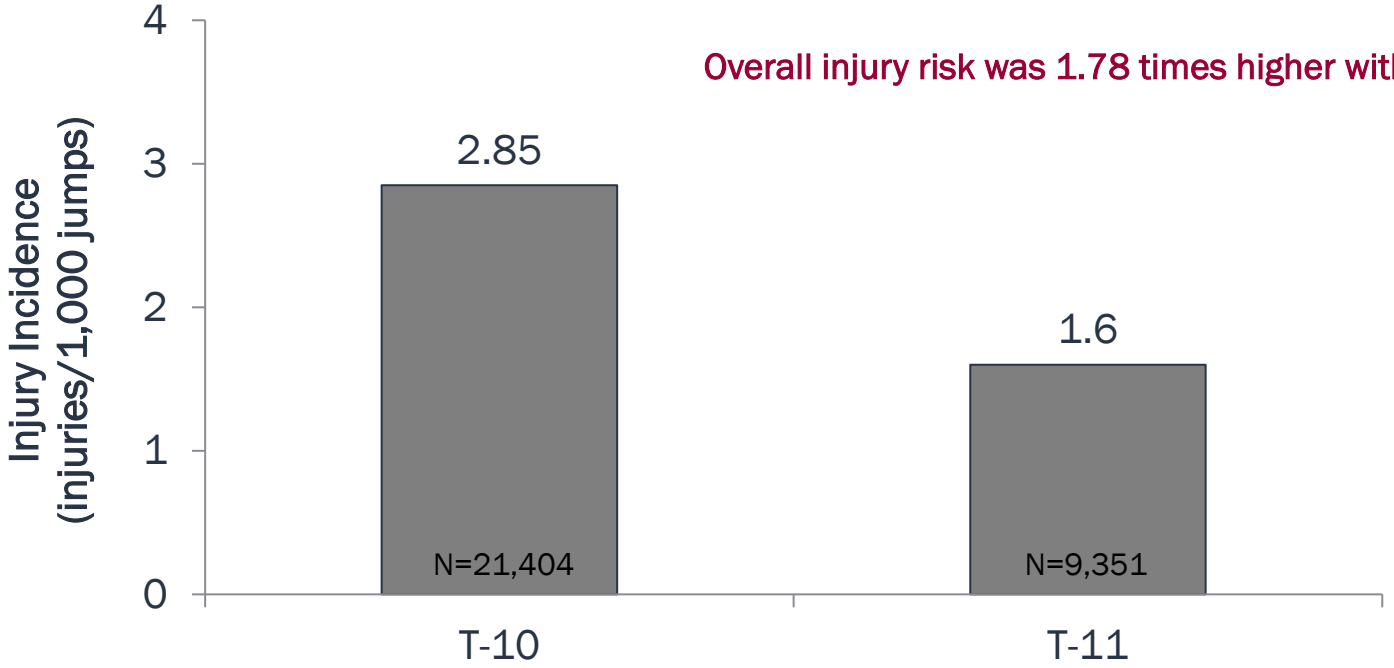
All Ankle Injuries, Parachute Ankle Brace



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.

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.

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.

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

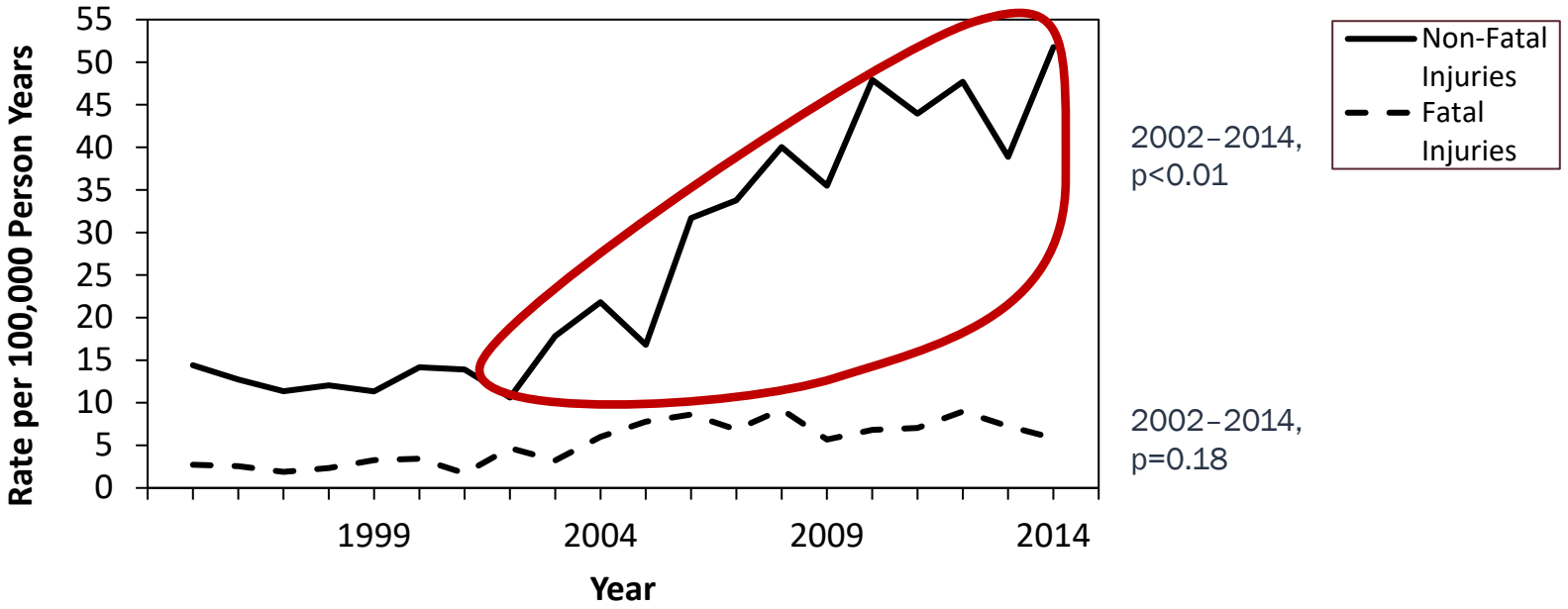


Figure 1. Trends in reported fatal* and non-fatal motorcycle traffic crash rates among Active Duty Army motorcyclists, Army safety reports, 1995–2014 (n=2,852); denominator data from Defense Medical Surveillance System
*Fewer than 20 fatalities per year from 1995 to 2003, except 2002

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

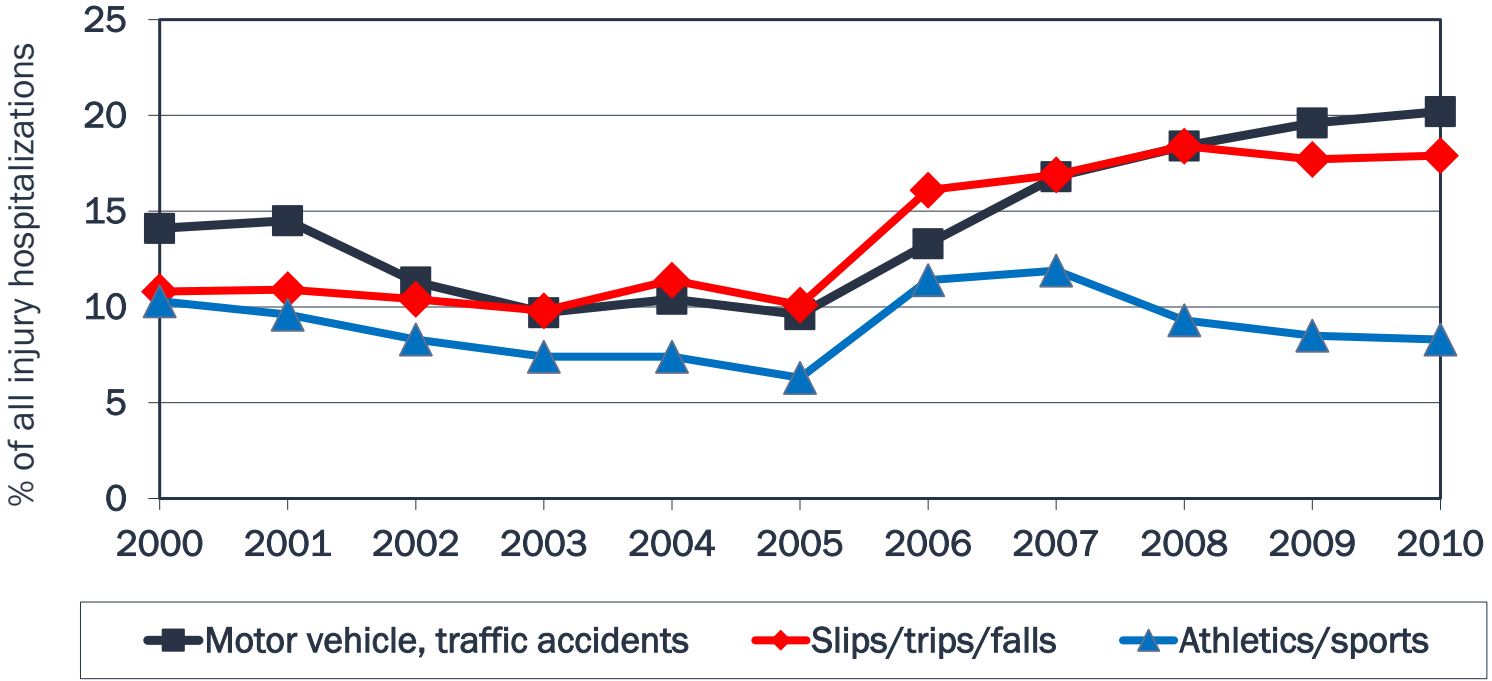
Risk Factors for Fatal Motorcycle Crash, Active Duty Army, 1995–2014

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	

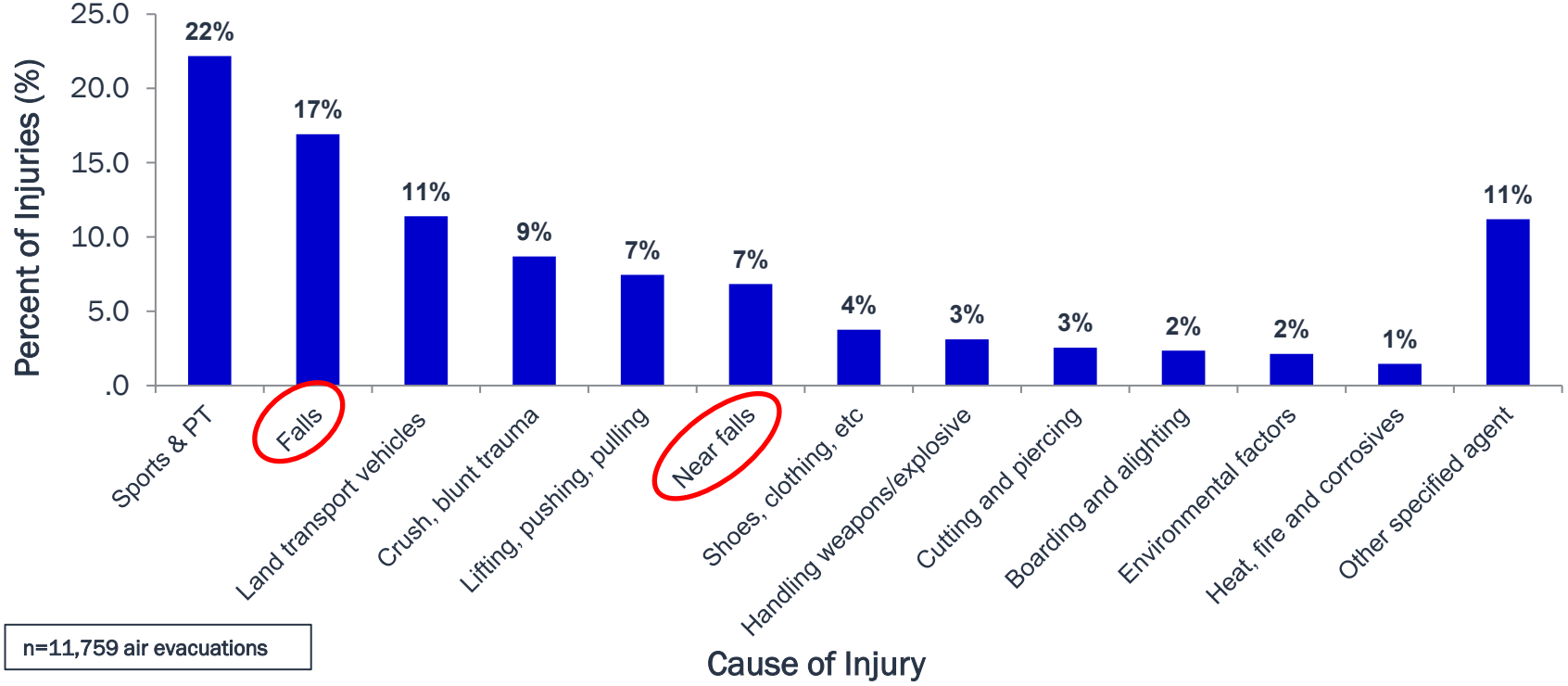
Bold text represents significance at p≤0.05.

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

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



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.