

Associations Between Neuromusculoskeletal Injuries and Pelvic Floor Disorders in Active Duty Service Women 2017-2022

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with the Center for Advanced Research for Military Optimization, Readiness, and Rehabilitation (ARMORR)

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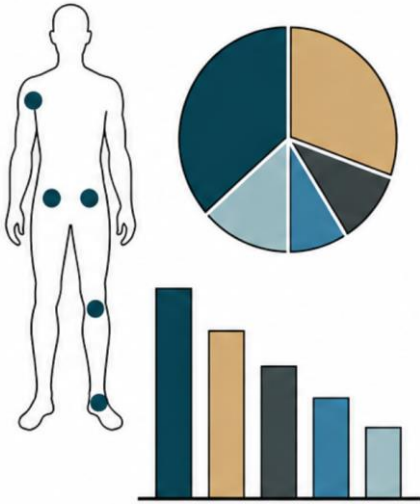
PI: Dr. Kalyn C. Jannace

Study Team

- Dr. Kalyn C. Jannace, PhD MPH - Principal Investigator
- Anna C. Enge, MS
- Stanley T. Zimmerman, MPH
- Bhavna Singichetti, PhD MPH

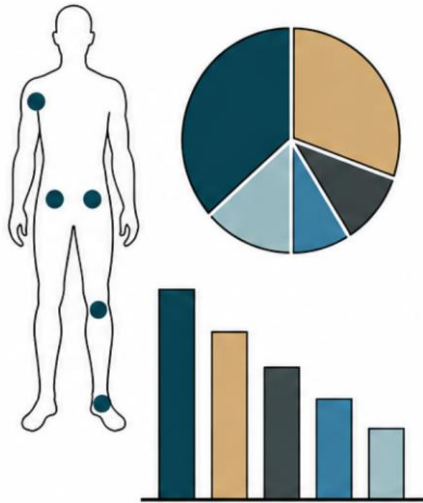
Learning Objectives

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- Describe the distribution of prevalent neuromusculoskeletal injuries (NMSKIs) among ADSW with an incident PFD

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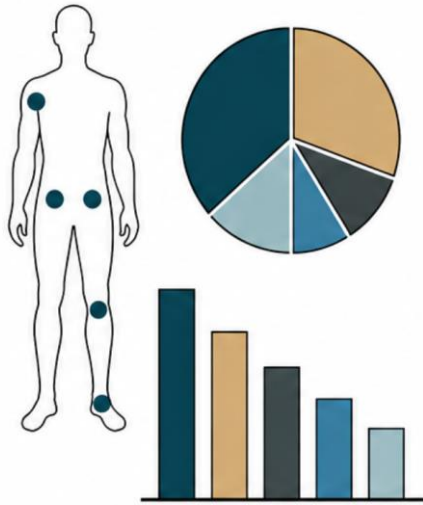


- Describe the distribution of prevalent neuromusculoskeletal injuries (NMSKIs) among ADSW with an incident PFD



- Evaluate associations between incident PFD subtypes and prevalent NMSKIs

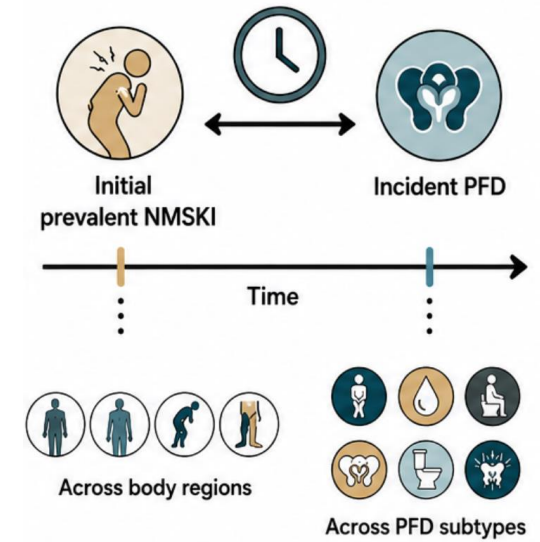
Learning Objectives



- Describe the distribution of prevalent neuromusculoskeletal injuries (NMSKIs) among ADSW with an incident PFD



- Evaluate associations between incident PFD subtypes and prevalent NMSKIs



- Assess variation in timing between prevalent NMSKI and incident PFD across body regions and incident PFD subtypes

Pelvic Floor Disorders (PFDs)

- Includes stress incontinence, fecal incontinence, and pelvic pain/discomfort
- **Affects ~10% of active-duty service women (ADSW)**
- Often comorbid with other musculoskeletal issues, chronic pain and psychological distress
- **Ultimately impacts health and operational readiness**

→ *Yet existing evidence is limited*



The appearance of U.S. Department of War (DoW) visual information does not imply or constitute DoW endorsement.

Methods

STUDY DESIGN



Retrospective Cohort

Using data from the
Military Health System
Data Repository (MDR)

⋮



Study Period

January 1, 2017 –
December 31, 2022

STUDY POPULATION



Active Duty Service Women (ADSW)

Ages 18–64 years

Inclusion Criteria

- At least 1 encounter in MHS during the study period
- Incident pelvic floor disorder (PFD) between 2017 and 2022

Exclusion Criteria

- Prevalent PFD prior to cohort entry

CASE DEFINITIONS



International
Classification of
Diseases, 10th Revision
(ICD-10) codes
defined prevalent
NMSKIs and
incident PFDs.

STATISTICAL ANALYSIS



Unadjusted Statistical Analysis

To estimate the associations between
demographics, military characteristics,
PFD subtypes, and prevalent NMSKIs.



Adjusted Multivariable Statistical Analysis

To estimate associations between
PFD subtypes and prevalent NMSKIs.

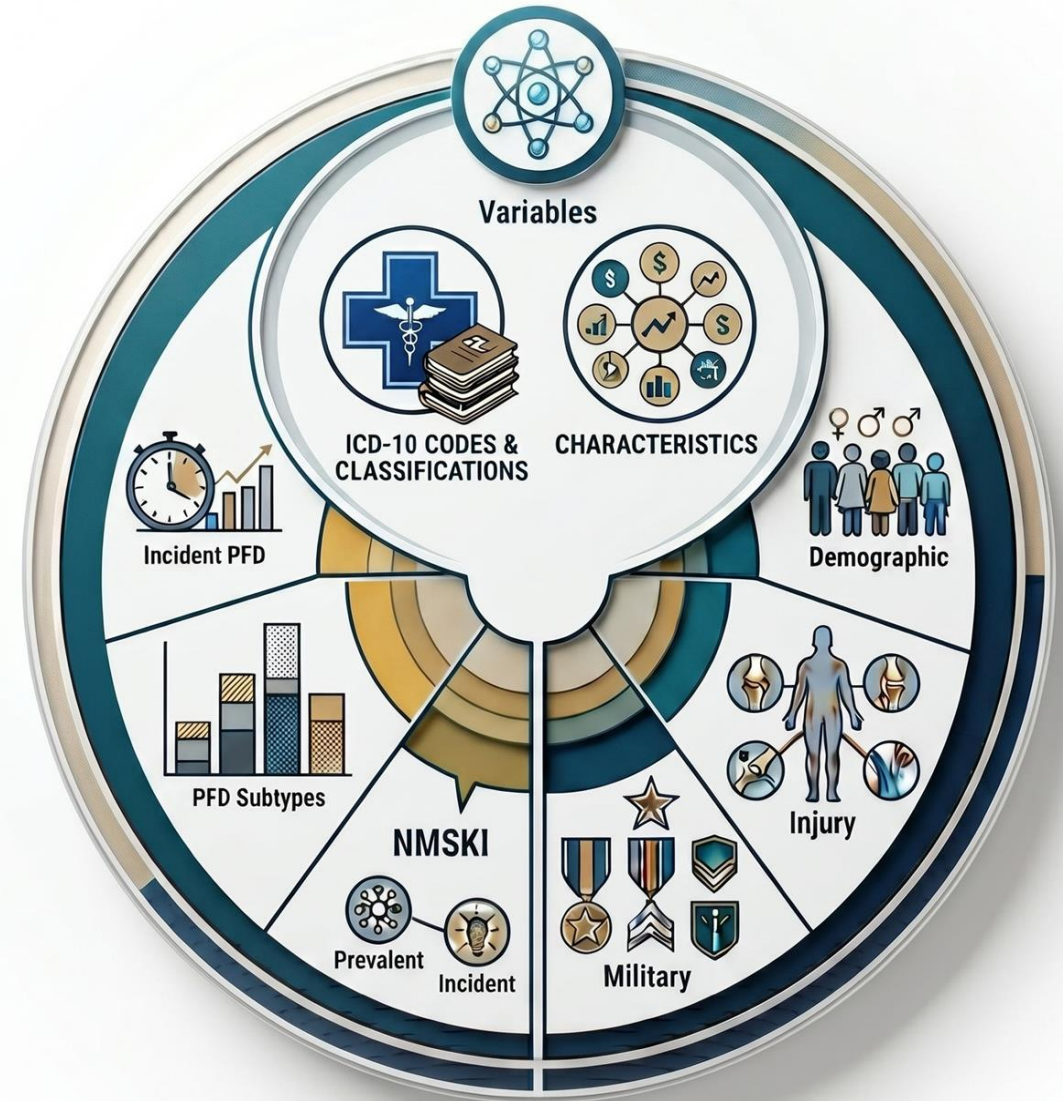


Unadjusted Survival Analysis

To assess the time from initial
prevalent NMSKI to incident PFD
by body region and PFD subtype.

Variable Definitions

- Dependent variable: Prevalent NMSKI
- Independent variables:
 - Incident PFD subtype
 - Prevalent NMSKI primary body region
- Covariates:
 - Demographic Characteristics
 - Health Characteristics
 - Military Characteristics



Results

ADSW with a Prevalent NMSKI

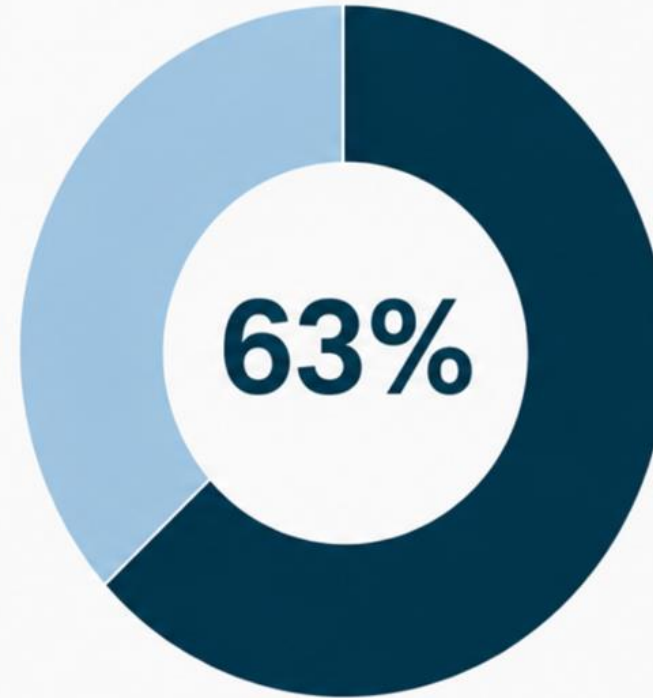


87,206

ADSW with
an incident PFD

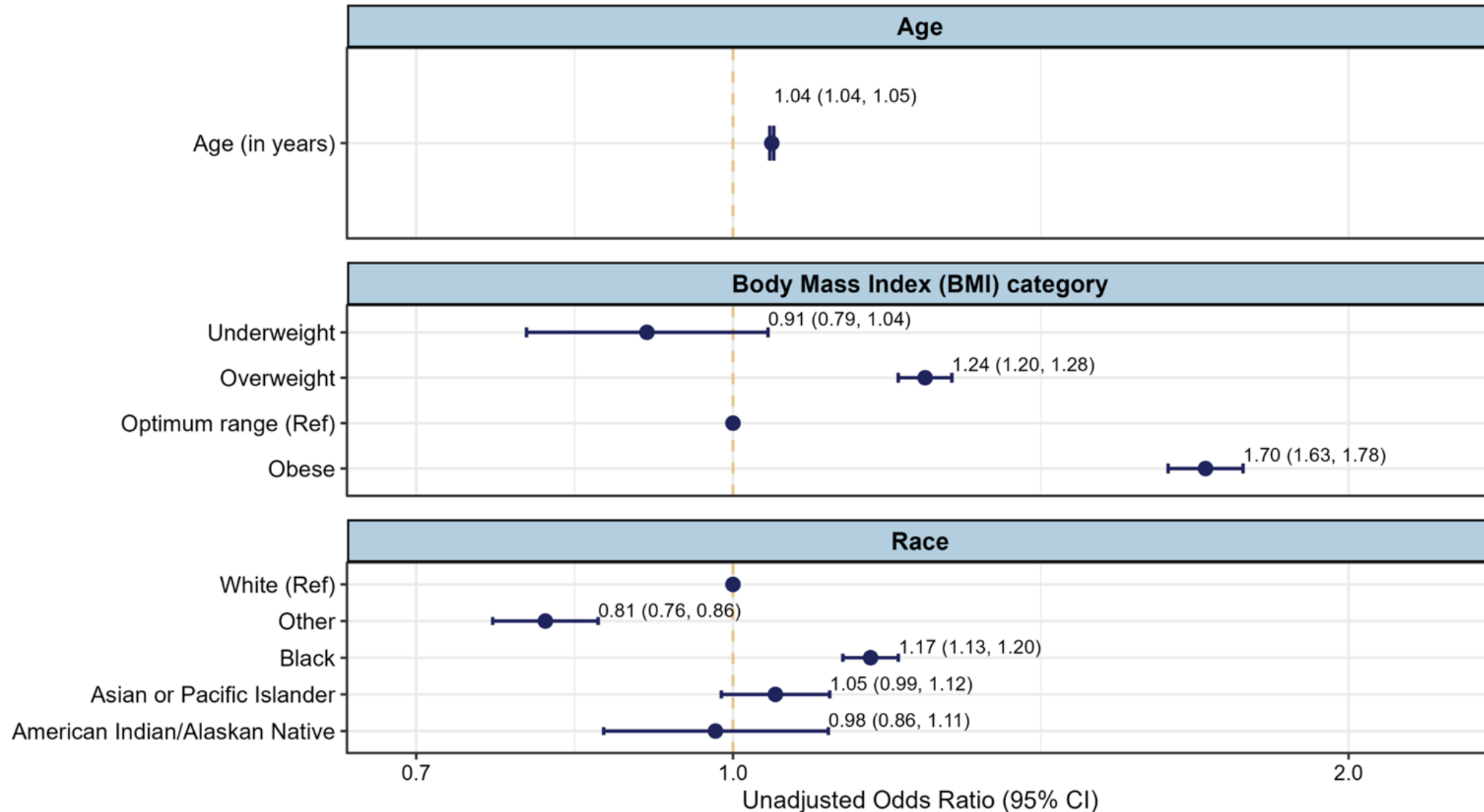


- Had a prevalent NMSKI (63%)
- Did not have a prevalent NMSKI (37%)

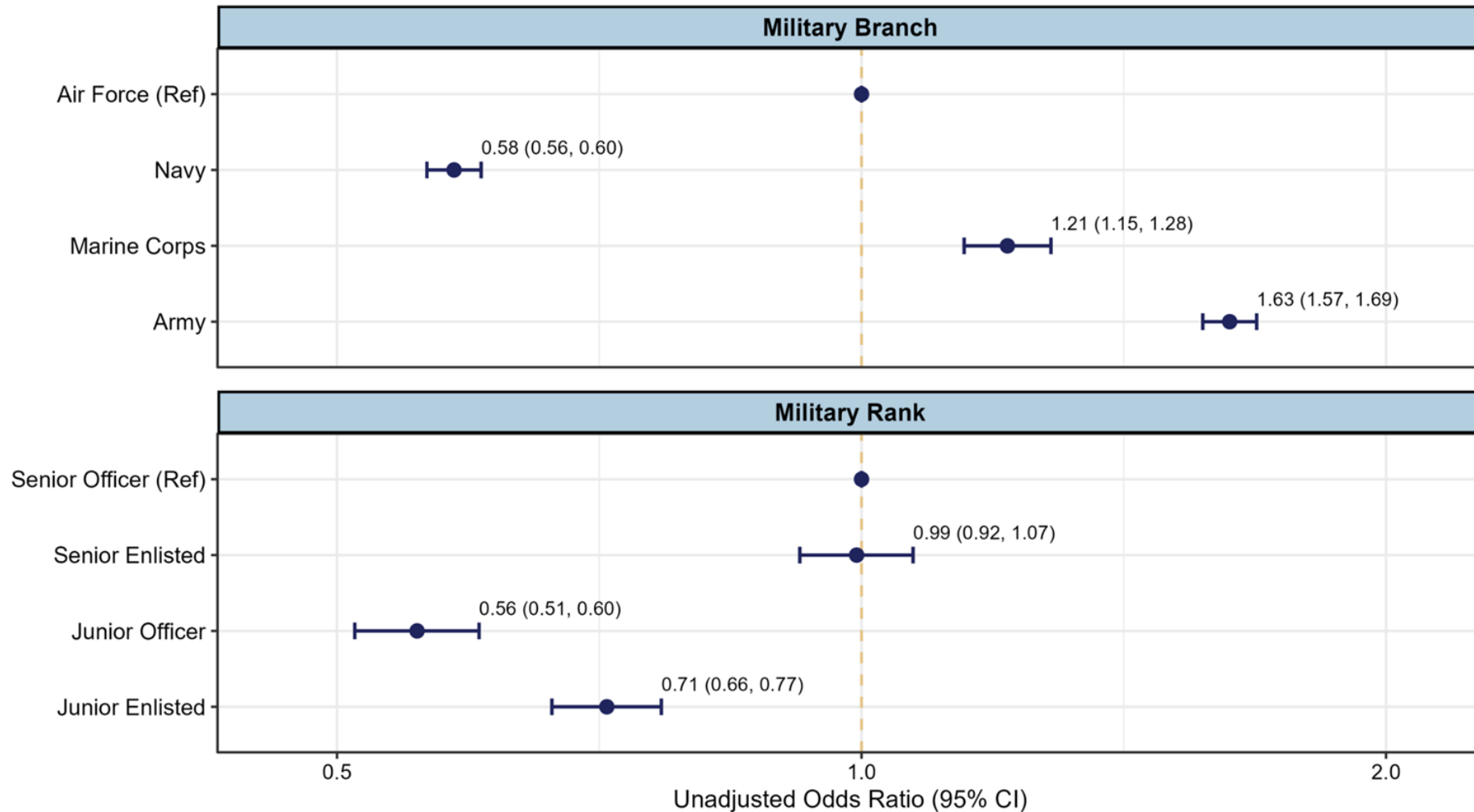


of ADSW
with an
incident PFD
had a
**prevalent
NMSKI**

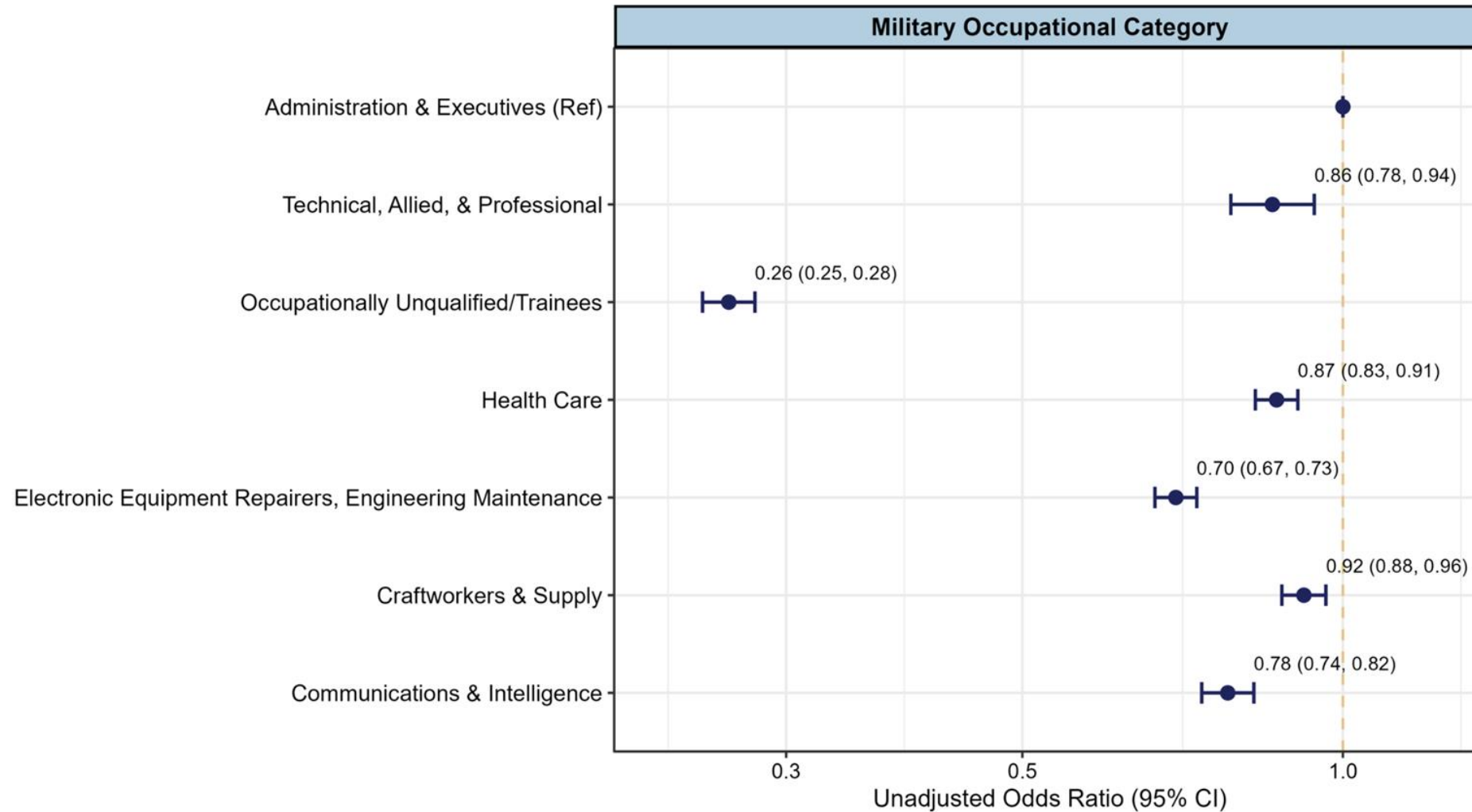
Unadjusted Odds of a Prevalent NMSKI



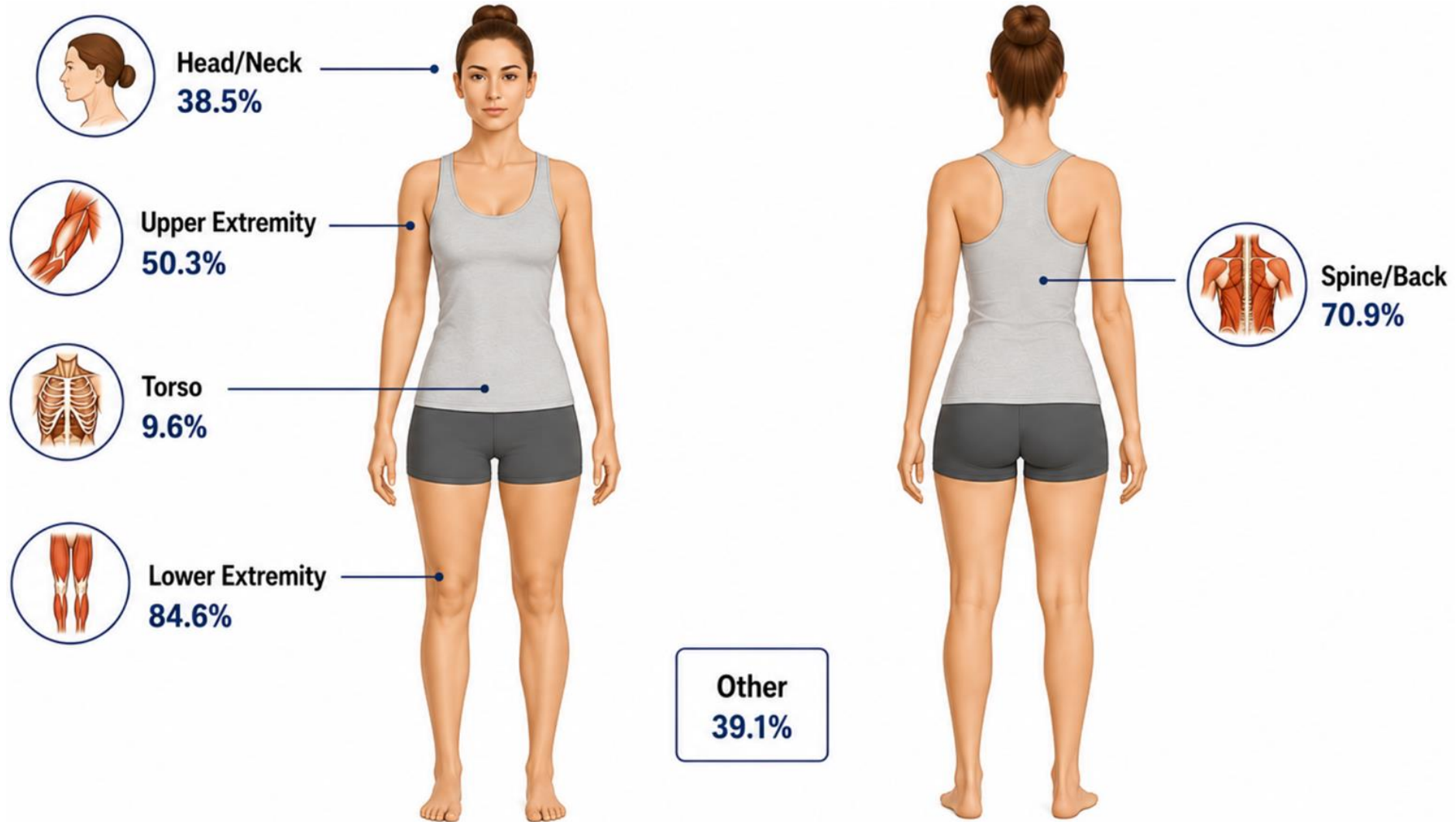
Unadjusted Odds of a Prevalent NMSKI



Unadjusted Odds of a Prevalent NMSKI



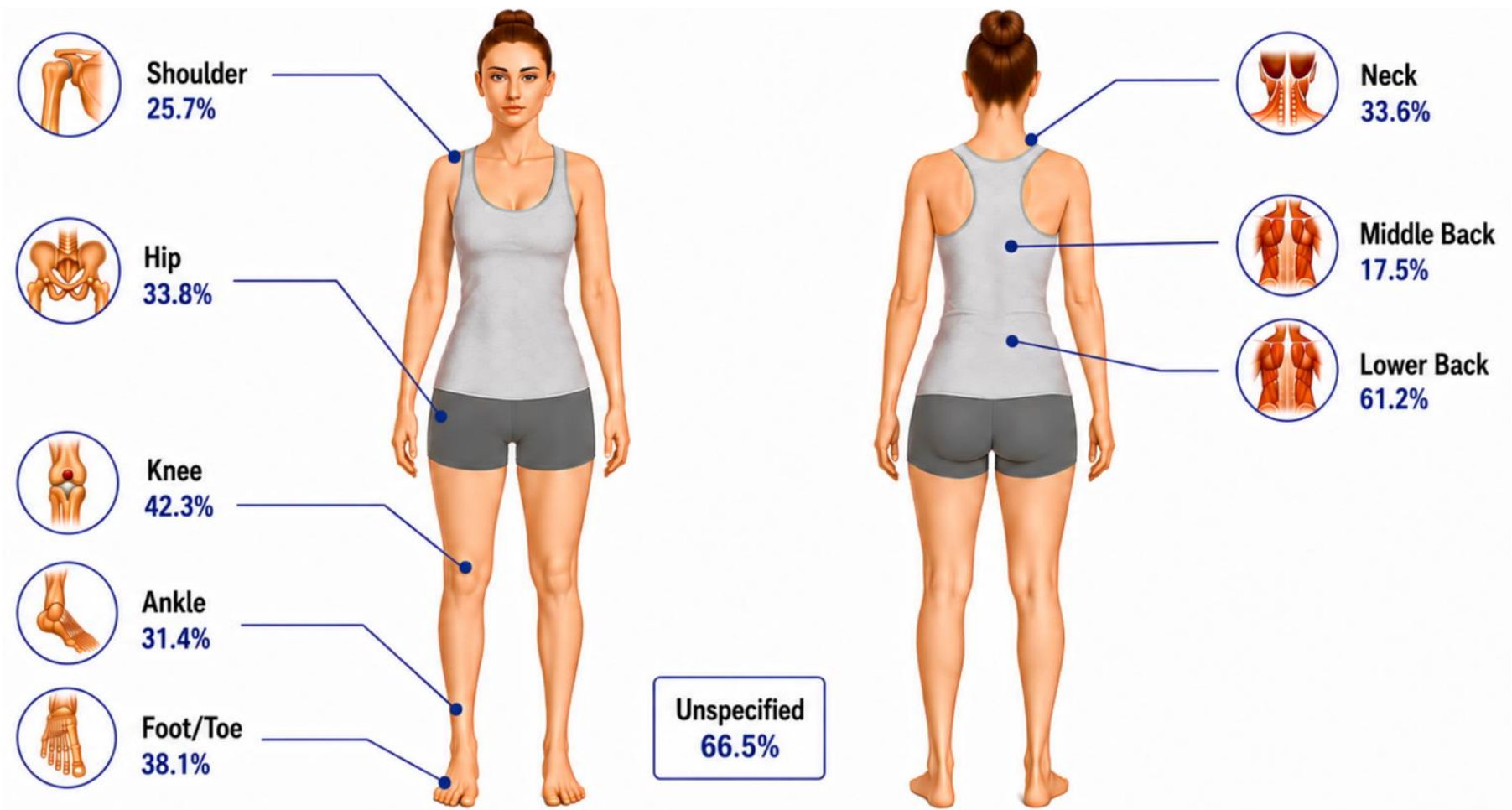
Prevalent NMSKI Primary Body Regions among ADSW with an Incident PFD



Percentages may sum to more than 100% because women may have NMSKI in more than one body region.

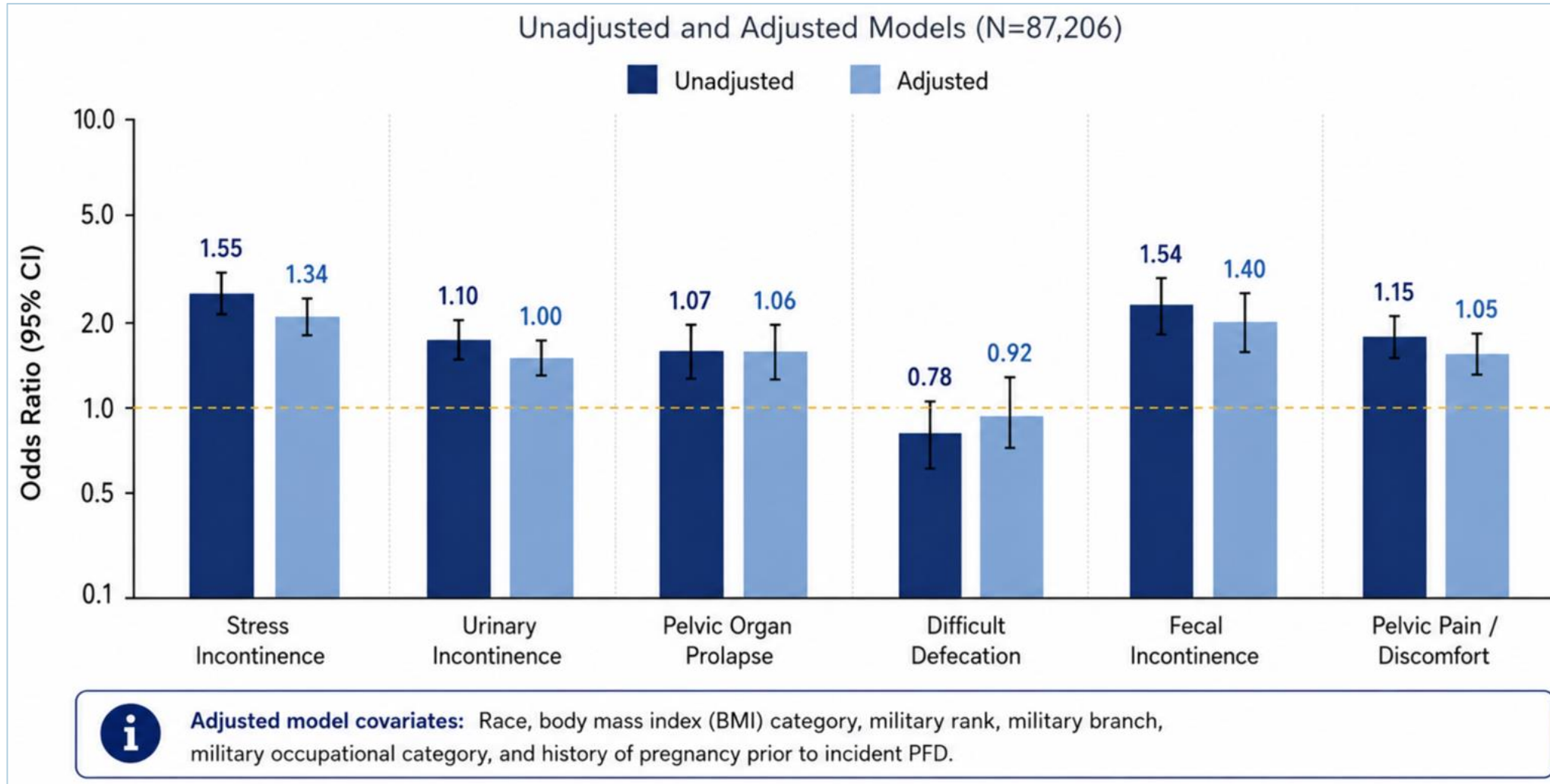
Concept designed by Anna Enge, stylized with Google Gemini

Prevalent NMSKI Secondary Body Regions among ADSW with an Incident PFD

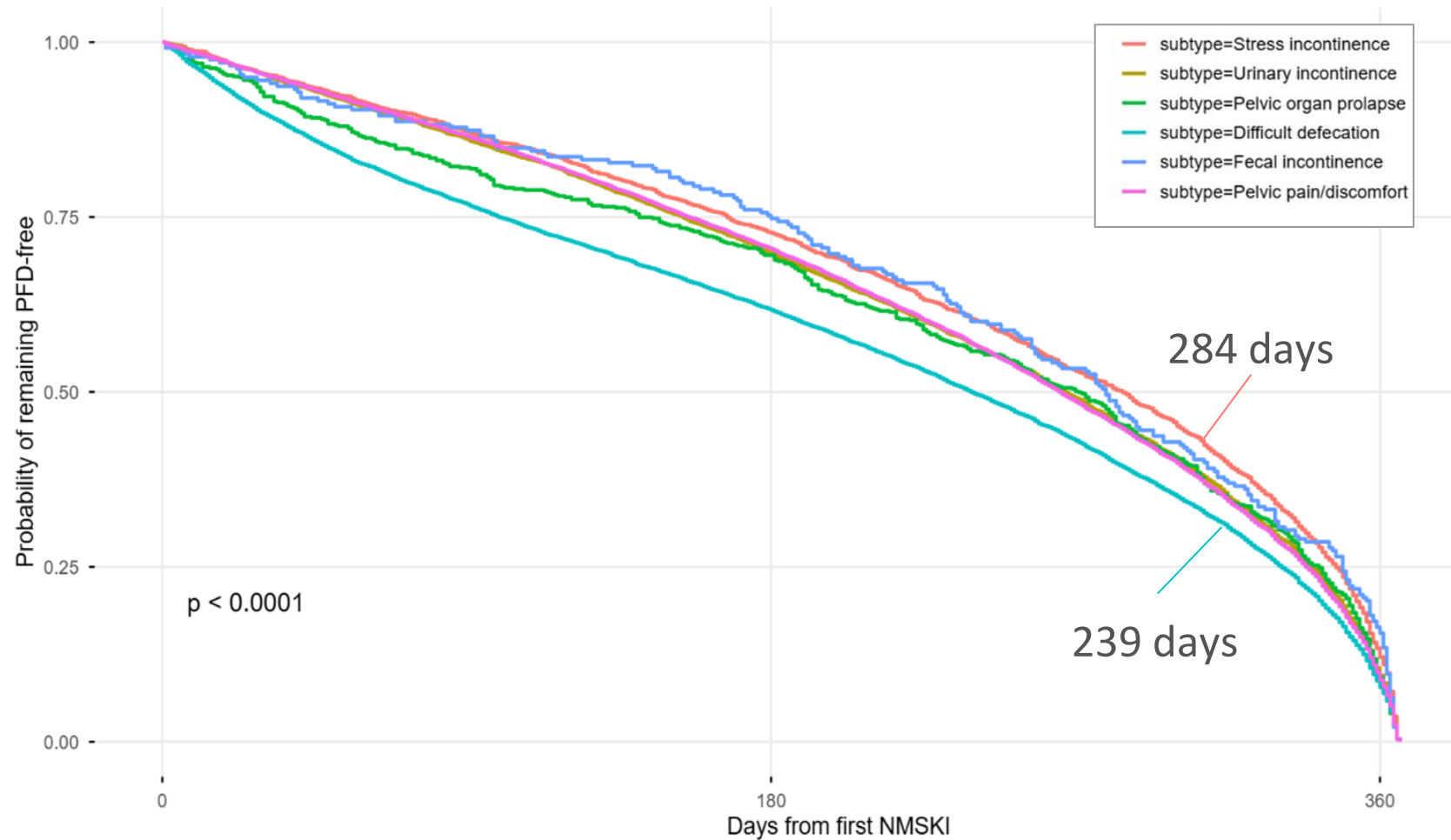


* Body regions shown include only those with prevalence greater than 20%.
Percentages may sum to more than 100% because women may have NMSKI in more than one body region.

Odds of Prevalent NMSKI by Incident PFD Subtype

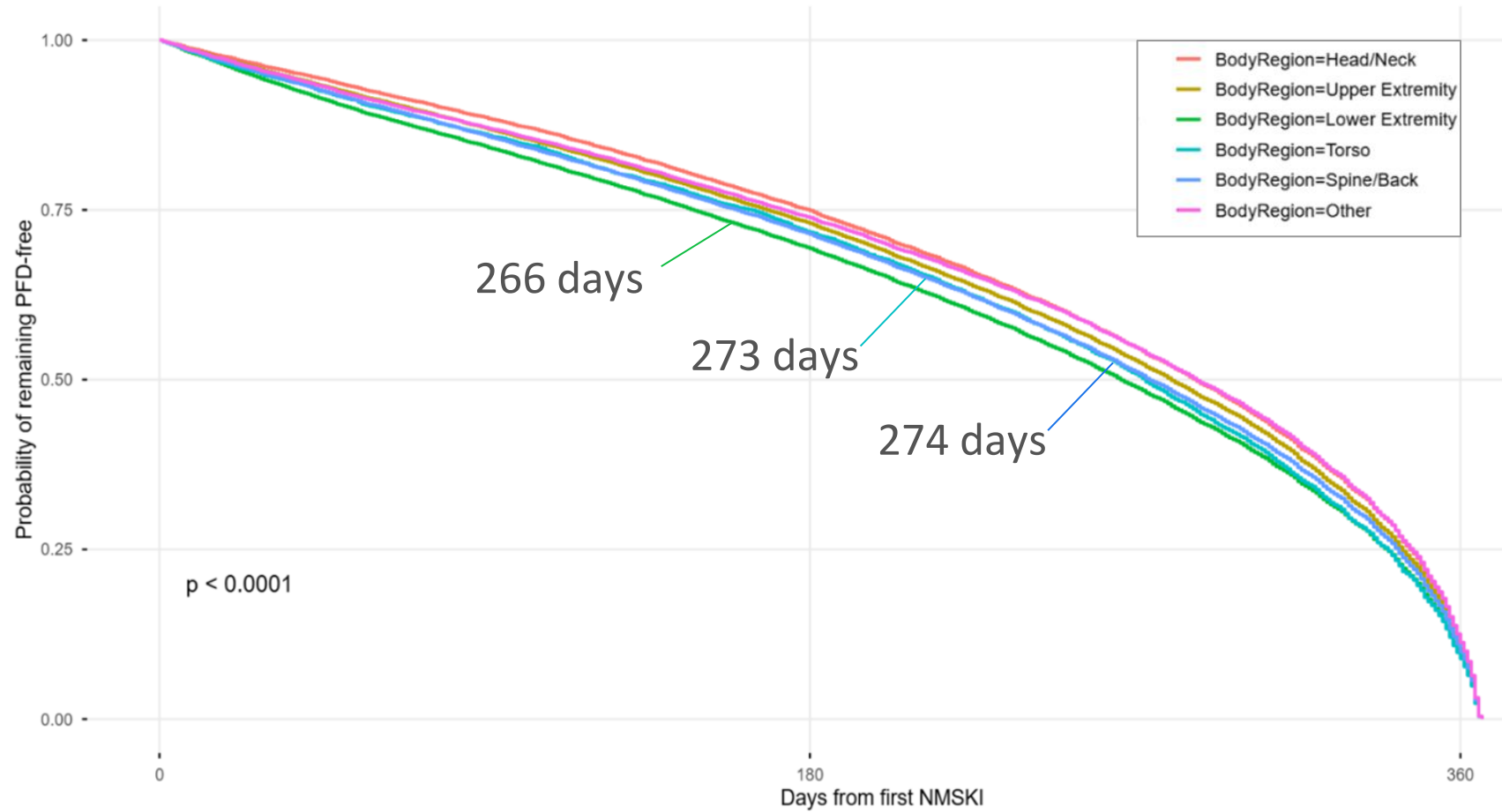


Time from NMSKI to Incident PFD by PFD Subtype



Incident PFD subtype	n (%)	Median days [IQR]
Stress incontinence	2490 (4.5%)	284 [167, 347]
Urinary incontinence	8737 (15.8%)	267 [154, 340]
Pelvic organ prolapse	591 (1.1%)	271 [143, 342]
Difficult defecation	17267 (31.2%)	239 [100, 331]
Fecal incontinence	238 (0.4%)	279 [180, 349]
Pelvic pain/discomfort	27670 (50.0%)	266 [156, 338]

Time from NMSKI to Incident PFD by Body Region



Primary Body Region	n (%)	Median days [IQR]
Head/Neck	21299 (38.5%)	287 [180, 346]
Upper Extremity	27842 (50.3%)	280 [168, 344]
Lower Extremity	46800 (84.6%)	266 [148, 340]
Torso	5338 (9.6%)	273 [164, 340]
Spine/Back	39249 (70.9%)	274 [160, 343]
Other	21638 (39.1%)	287 [173, 347]

Discussion: Interpretation of Findings



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Discussion: Interpretation of Findings

- High prevalence of NMSKIs among ADSW diagnosed with incident PFDs



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Discussion: Interpretation of Findings

- High prevalence of NMSKIs among ADSW diagnosed with incident PFDs
- Prevalent PFDs
 - clustered in load-bearing regions (e.g., lower extremity and back/spine)
 - more likely to be associated with specific PFD



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Discussion: Interpretation of Findings

- High prevalence of NMSKIs among ADSW diagnosed with incident PFDs
- Prevalent PFDs
 - clustered in load-bearing regions (e.g., lower extremity and back/spine)
 - more likely to be associated with specific PFD
- Stress incontinence and fecal incontinence had the strongest associations with prevalent NMSKIs



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Discussion: Implications and Further Research

Clinical and Operational Implications:

- PFDs and NMSKIs may represent interconnected conditions
- Pelvic floor screening during NMSKI injury encounters
- ADSW with lower extremity and spine/back injuries may be at an elevated risk for future PFD development
- Integrated neuromuscular and pelvic health approaches may improve force health protection and readiness

Further Research:

- Determine whether specific NMSKI body regions precede certain PFD subtypes
- Explore biomechanical and neuromuscular mechanisms underlying the NMSKI–PFD relationship
- Evaluate whether earlier screening improves outcomes

Strengths and Limitations

Strengths and Limitations



STRENGTHS



Large Military Population



Comprehensive Health
System Data



Incident PFD Cohort Design



Multiple PFD Subtypes Evaluated



Adjustment for Important Covariates

Strengths and Limitations



STRENGTHS



Large Military Population



Comprehensive Health System Data



Incident PFD Cohort Design



Multiple PFD Subtypes Evaluated



Adjustment for Important Covariates



LIMITATIONS



Administrative Claims Data



Detection and Healthcare-Seeking Bias



Temporal Ordering Does Not Establish Causation



Potential Residual Confounding



Limited Generalizability

Strengths and Limitations



STRENGTHS



Large Military Population



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TAKE-HOME MESSAGE

Prevalent NMSKIs were common among ADSW with incident PFDs, particularly involving the lower extremity and spine/back, highlighting opportunities for earlier screening and intervention to support military readiness.



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Questions?

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Demographic and Military Characteristics of ADSW with an Incident PFD	Overall (N = 87,206)	No Prevalent NMSKI (n = 31,859)	Prevalent NMSKI (n = 55,347)	OR (95% CI)
Age, Mean (SD)	26.3 (6.7)	25.1 (6.0)	26.9 (7.0)	1.04 (1.04, 1.05)
Race, n (%)				
American Indian or Alaskan native	1,043 (1.2)	394 (1.3)	649 (1.2)	0.94 (0.83, 1.07)
Asian or Pacific islander	4,914 (5.7)	1,779 (5.6)	3,135 (5.7)	1.01 (0.95, 1.07)
Black	26,903 (31.1)	9,084 (28.8)	17,819 (32.4)	1.18 (1.15, 1.22)
White	48,632 (56.3)	18,146 (57.6)	30,486 (55.5)	0.92 (0.89, 0.94)
Other	4,942 (5.7)	2,094 (6.6)	2,848 (5.2)	0.77 (0.72, 0.81)
BMI category, n (%)				
Obese	13,977 (16.1)	3,981 (12.5)	9,996 (18.1)	1.54 (1.48, 1.60)
Overweight	34,579 (39.8)	12,214 (38.5)	22,365 (40.5)	1.09 (1.06, 1.12)
Optimum range	37,559 (43.2)	15,176 (47.8)	22,383 (40.5)	0.74 (0.72, 0.76)
Underweight	870 (1.0)	372 (1.2)	498 (0.9)	0.77 (0.67, 0.88)
Military rank, n (%)				
Junior enlisted	48,910 (56.4)	18,775 (59.4)	30,135 (54.7)	0.82 (0.80, 0.85)
Senior enlisted	25,724 (29.6)	7,957 (25.2)	17,767 (32.2)	1.41 (1.37, 1.46)
Junior officer	8,452 (9.7)	3,758 (11.9)	4,694 (8.5)	0.69 (0.66, 0.72)
Senior officer	3,676 (4.2)	1,132 (3.6)	2,544 (4.6)	1.30 (1.21, 1.40)
Military branch, n (%)				
Air Force	26,126 (30.0)	9,675 (30.4)	16,451 (29.7)	0.97 (0.94, 1.00)
Army	30,972 (35.5)	8,224 (25.8)	22,748 (41.1)	2.01 (1.95, 2.07)
Marine Corps	6,568 (7.5)	2,145 (6.7)	4,423 (8.0)	1.20 (1.14, 1.27)
Navy	23,540 (27.0)	11,815 (37.1)	11,725 (21.2)	0.46 (0.44, 0.47)
Military occupation, n (%)				
Administration & Executives	19,476 (22.9)	5,814 (18.8)	13,662 (25.3)	1.45 (1.41, 1.51)
Communications & Intelligence	7,513 (8.8)	2,653 (8.6)	4,860 (9.0)	1.05 (1.00, 1.10)
Craftworkers & Supply	13,375 (15.7)	4,233 (13.7)	9,142 (16.9)	1.28 (1.23, 1.33)
Electronic Equipment Repairers, Engineering Maintenance	14,777 (17.4)	5,603 (18.2)	9,174 (17.0)	0.92 (0.89, 0.95)
Health Care	14,964 (17.6)	4,929 (16.0)	10,035 (18.5)	1.20 (1.15, 1.24)
Infantry/Tactical Operations	5,296 (6.2)	2,420 (7.8)	2,876 (5.3)	0.66 (0.62, 0.70)
Technical, Allied & Professional	2,411 (2.8)	799 (2.6)	1,612 (3.0)	1.16 (1.06, 1.26)
Operationally Unqualified	7,143 (8.4)	4,402 (14.3)	2,741 (5.1)	0.32 (0.31, 0.34)
Abbreviations: PFD = Pelvic Floor Disorder; NMSKI = Neuromusculoskeletal Injury; CI = Confidence Interval, OR = Odds Ratio				

Injury Characteristics of ADSW with an Incident PFD	Overall (N = 87,206)	No Prevalent NMSKI (n = 31,859)	Prevalent NMSKI (n = 55,347)	OR (95% CI)
NMSKI primary body region				
Head/neck	26,284 (30.1)	4,985 (15.6)	21,299 (38.5)	3.37 (3.26, 3.49)
Upper extremity	34,986 (40.1)	7,144 (22.4)	27,842 (50.3)	3.50 (3.39, 3.61)
Lower extremity	60,930 (69.9)	14,130 (44.4)	46,800 (84.6)	6.87 (6.65, 7.09)
Torso	6,641 (7.6)	1,303 (4.1)	5,338 (9.6)	2.50 (2.35, 2.66)
Spine/back	51,048 (58.5)	11,799 (37.0)	39,249 (70.9)	4.15 (4.03, 4.27)
Other	26,903 (30.8)	5,265 (16.5)	21,638 (39.1)	3.24 (3.13, 3.36)
NMSKI primary injury type				
Amputation/crush/polytrauma	616 (0.7)	136 (0.4)	480 (0.9)	2.04 (1.69, 2.48)
Contusion	6,806 (7.8)	1,307 (4.1)	5,499 (9.9)	2.58 (2.42, 2.74)
Degenerative	12,764 (14.6)	1,564 (4.9)	11,200 (20.2)	4.91 (4.65, 5.19)
Dislocation/subluxation	2,110 (2.4)	317 (1.0)	1,793 (3.2)	3.33 (2.96, 3.76)
Fracture	5,761 (6.6)	1,087 (3.4)	4,674 (8.4)	2.61 (2.44, 2.79)
Nerve	17,762 (20.4)	2,690 (8.4)	15,072 (27.2)	4.06 (3.89, 4.24)
Overuse/non-specific	76,102 (87.3)	21,417 (67.2)	54,685 (98.8)	40.3 (37.2, 43.7)
Sprain/joint damage	19,097 (21.9)	3,264 (10.2)	15,833 (28.6)	3.51 (3.37, 3.66)
Strain/tear	17,259 (19.8)	3,236 (10.2)	14,023 (25.3)	3.00 (2.88, 3.13)
Stress fracture	3,263 (3.7)	498 (1.6)	2,765 (5.0)	3.31 (3.01, 3.65)
Systemic/genetic	6,096 (7.0)	833 (2.6)	5,263 (9.5)	3.91 (3.64, 4.22)

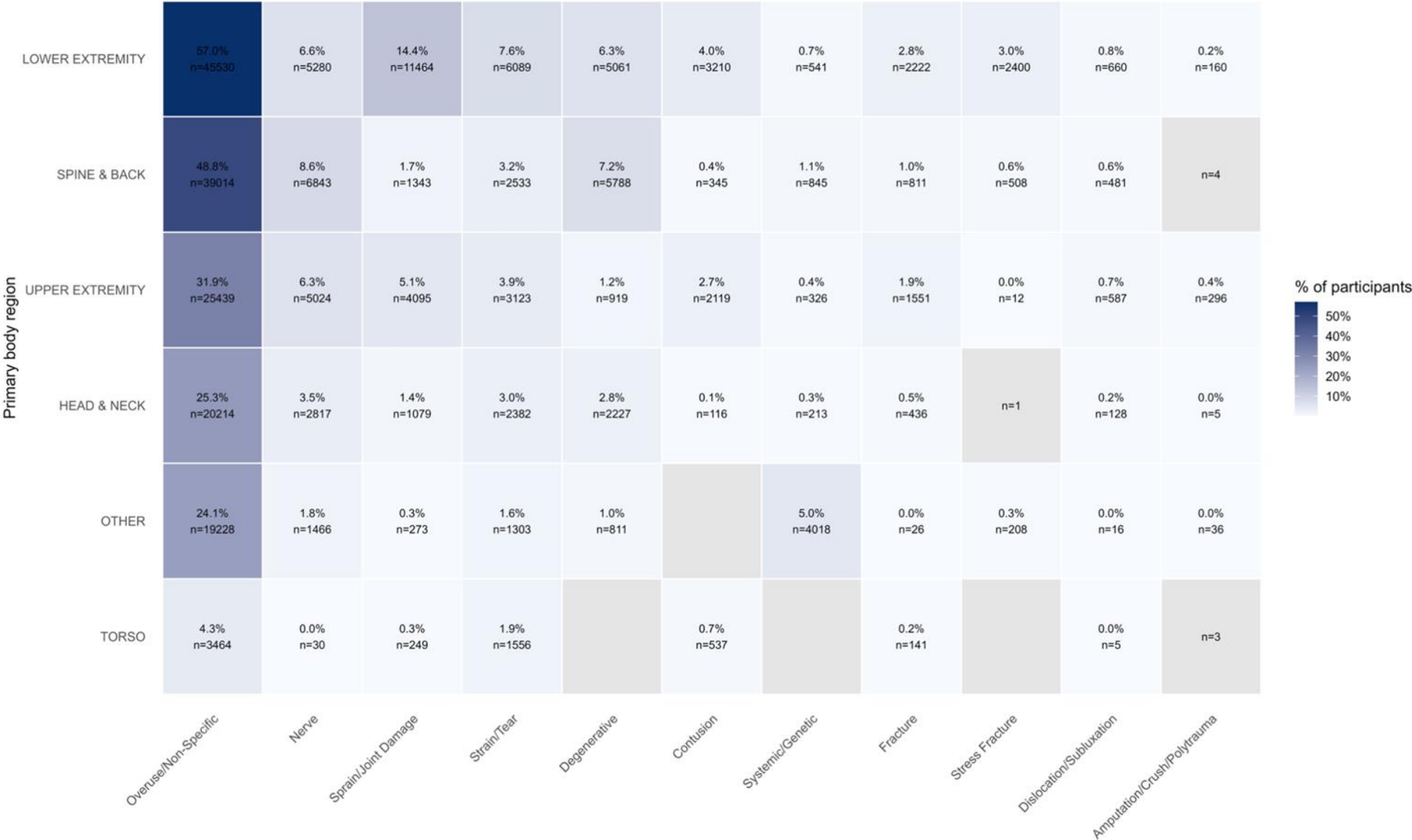
Abbreviations: PFD = Pelvic Floor Disorder; NMSKI = Neuromusculoskeletal injury; CI = Confidence Interval, OR = Odds Ratio

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NMSKI secondary body region				
Abdomen	1,182 (1.4)	271 (0.9)	911 (1.6)	1.95 (1.70, 2.24)
Ankle	21,283 (24.4)	3,897 (12.2)	17,386 (31.4)	3.29 (3.16, 3.41)
Arm lower	1,774 (2.0)	276 (0.9)	1,498 (2.7)	3.18 (2.80, 3.63)
Arm upper	1,551 (1.8)	236 (0.7)	1,315 (2.4)	3.26 (2.84, 3.76)
Back lower	43,108 (49.4)	9,250 (29.0)	33,858 (61.2)	3.85 (3.74, 3.97)
Back middle	11,648 (13.4)	1,948 (6.1)	9,700 (17.5)	3.26 (3.10, 3.43)
Back upper	237 (0.3)	23 (0.1)	214 (0.4)	5.37 (3.57, 8.49)
Chest	5,730 (6.6)	1,088 (3.4)	4,642 (8.4)	2.59 (2.42, 2.77)
Elbow	4,061 (4.7)	615 (1.9)	3,446 (6.2)	3.37 (3.09, 3.68)
Eye	41 (0.0)	9 (0.0)	32 (0.1)	2.05 (1.02, 4.56)
Face	4,295 (4.9)	798 (2.5)	3,497 (6.3)	2.63 (2.43, 2.84)
Foot/toe	26,157 (30.0)	5,059 (15.9)	21,098 (38.1)	3.26 (3.15, 3.38)
Hand/finger	10,916 (12.5)	1,909 (6.0)	9,007 (16.3)	3.05 (2.90, 3.21)
Head	3,674 (4.2)	726 (2.3)	2,948 (5.3)	2.41 (2.22, 2.62)
Hip	22,642 (26.0)	3,934 (12.3)	18,708 (33.8)	3.62 (3.49, 3.76)
Knee	28,912 (33.2)	5,504 (17.3)	23,408 (42.3)	3.51 (3.39, 3.63)
Leg/lower	14,937 (17.1)	2,609 (8.2)	12,328 (22.3)	3.21 (3.07, 3.36)
Leg/upper	7,581 (8.7)	1,239 (3.9)	6,342 (11.5)	3.20 (3.01, 3.41)
Neck	22,716 (26.0)	4,122 (12.9)	18,594 (33.6)	3.40 (3.28, 3.53)
Pelvis	12,662 (14.5)	1,936 (6.1)	10,726 (19.4)	3.72 (3.53, 3.91)
Shoulder	17,182 (19.7)	2,967 (9.3)	14,215 (25.7)	3.37 (3.23, 3.51)
Unspecified	47,428 (54.4)	10,626 (33.4)	36,802 (66.5)	3.97 (3.85, 4.08)
Wrist	14,197 (16.3)	2,640 (8.3)	11,557 (20.9)	2.92 (2.79, 3.06)
Multiple	2,236 (2.6)	374 (1.2)	1,862 (3.4)	2.93 (2.62, 3.28)

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Prevalent NMSKI primary body region and injury type among participants with an incident PFD

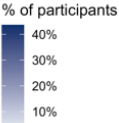
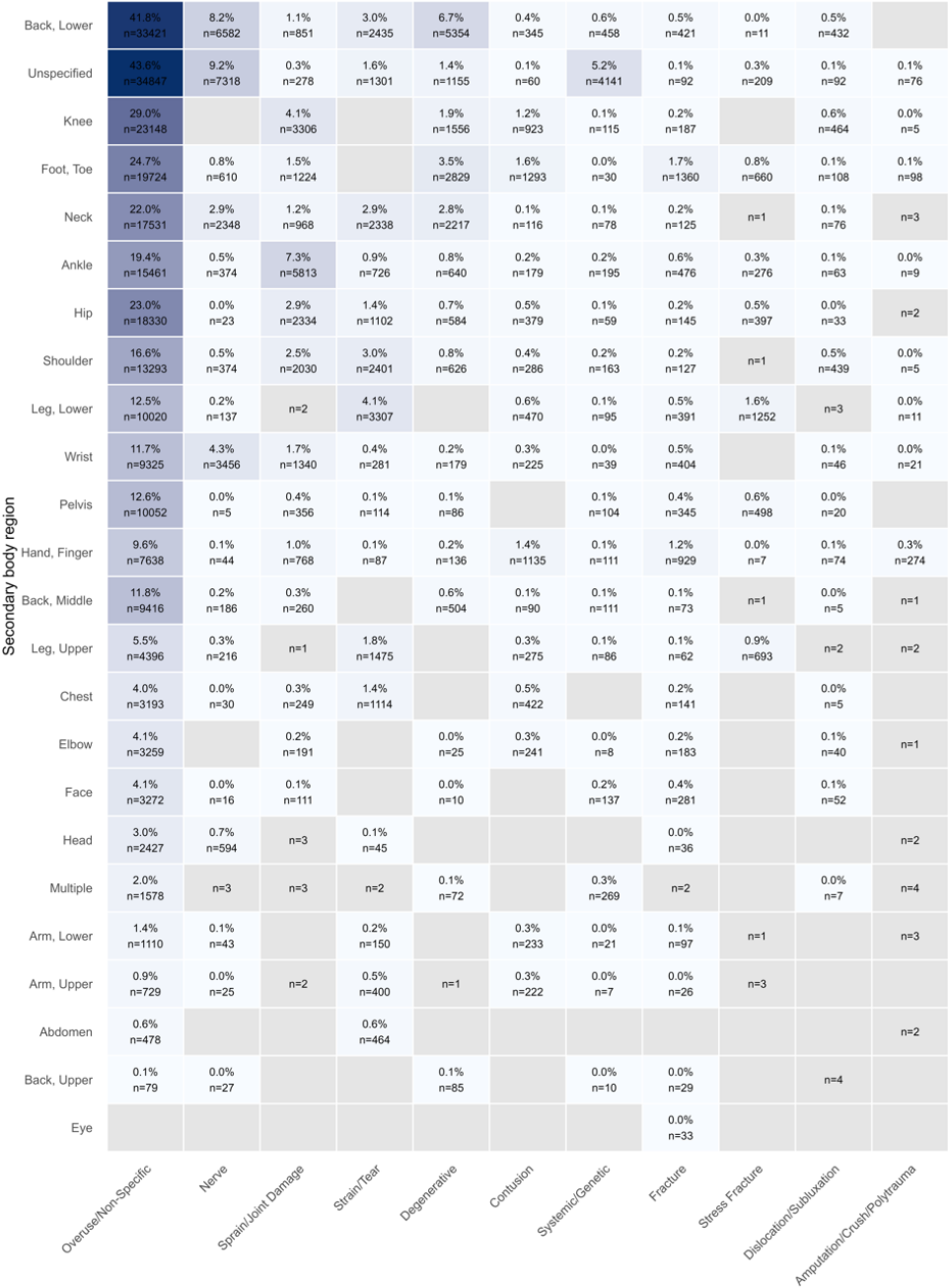
Each tile shows the percent of all participants with each prevalent NMSKI body region and injury type combination; cells with n < 5 shown in gray



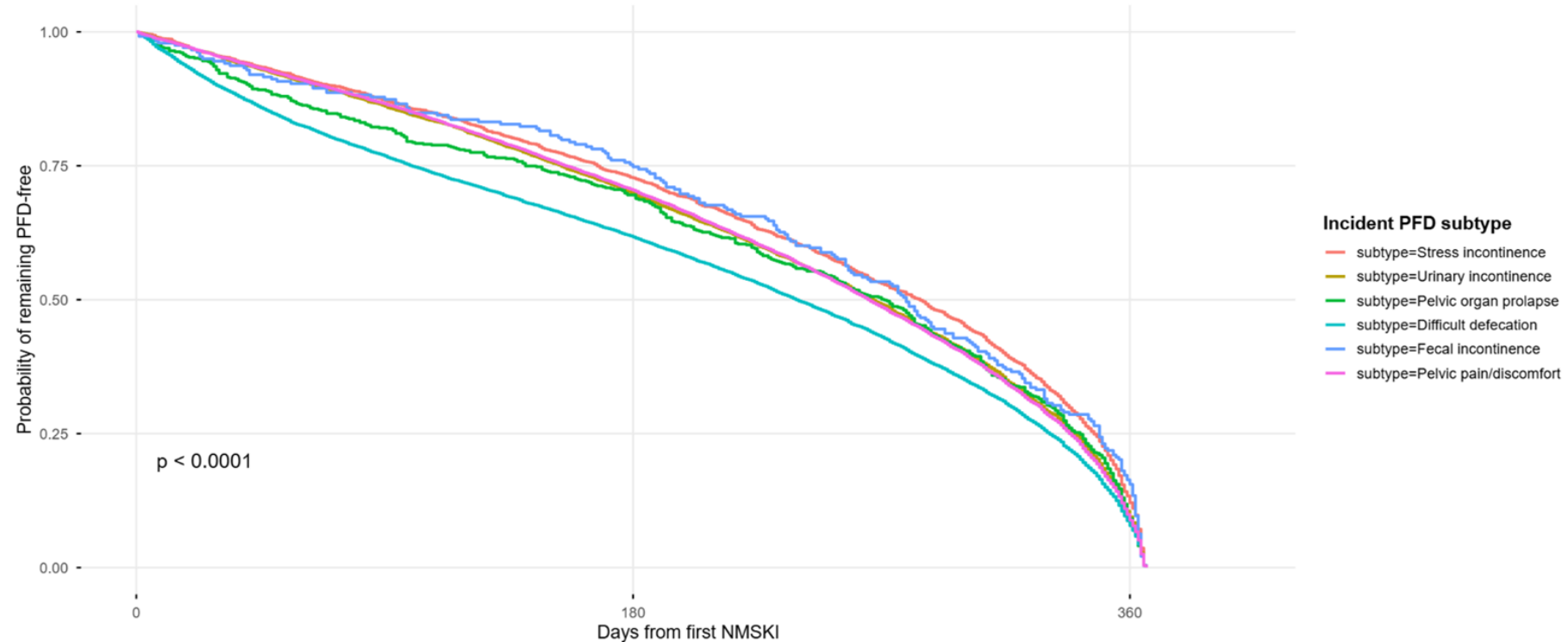
Total participants = 79865

Prevalent NMSKI secondary body region and injury type among participants with an incident PFD

Each tile shows the percent of all participants with each prevalent NMSKI body region and injury type combination; cells with n < 5 shown in gray



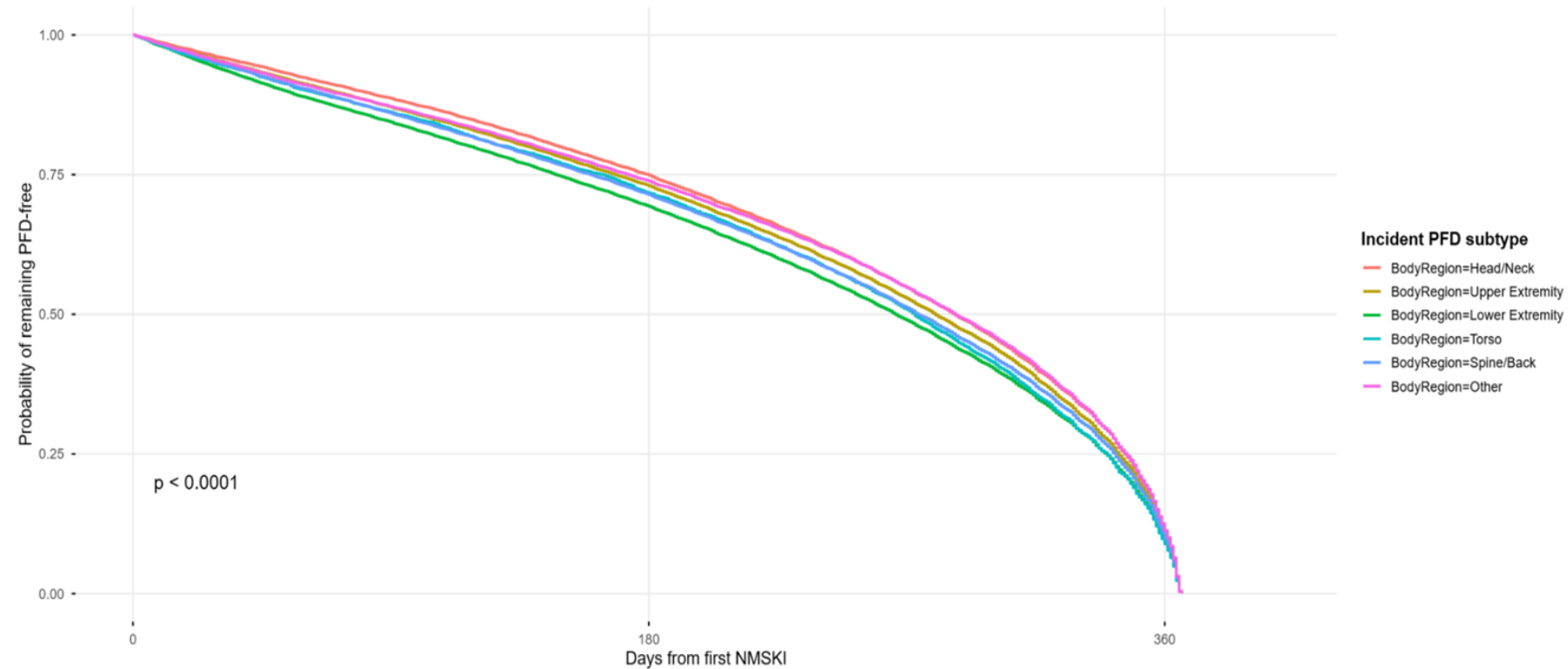
Time from NMSKI to Incident PFD by PFD Subtype



Median time from first NMSKI to incident PFD diagnosis by subtype

Incident PFD subtype	n (%)	Median days [IQR]
Stress incontinence	2490 (4.5%)	284 [167, 347]
Urinary incontinence	8737 (15.8%)	267 [154, 340]
Pelvic organ prolapse	591 (1.1%)	271 [143, 342]
Difficult defecation	17267 (31.2%)	239 [100, 331]
Fecal incontinence	238 (0.4%)	279 [180, 349]
Pelvic pain/discomfort	27670 (50.0%)	266 [156, 338]

Time from NMSKI to Incident PFD by Body Region



Median time from first NMSKI to incident PFD diagnosis by primary body region

Primary Body Region	n (%)	Median days [IQR]
Head/Neck	21299 (38.5%)	287 [180, 346]
Upper Extremity	27842 (50.3%)	280 [168, 344]
Lower Extremity	46800 (84.6%)	266 [148, 340]
Torso	5338 (9.6%)	273 [164, 340]
Spine/Back	39249 (70.9%)	274 [160, 343]
Other	21638 (39.1%)	287 [173, 347]