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Bone Stress Injuries During U.S. Army Basic Combat Training: A Retrospective Analysis, Fiscal Years 2018-2021

Injury Prevention Branch, DCPH -A
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This report has been updated in alignment with Executive Orders and to ensure consistency with DOD policies in public health reporting.

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Methods (1 of 4)

Ongoing Surveillance for Basic Combat Training (BCT)

- Timeframe of surveillance: fiscal year cohorts 2018–2021 (FYs 18–21)
  - Cohorts of trainees that started training during each FY
    - ✓ Trainees were followed until discharge or graduation from BCT
    - ✓ Trainees who graduated from BCT were followed for an additional 6 months
- Population
  - BCT trainees at four training sites
  - Trainees included Active, Reserve, and National Guard Soldiers
- Data sources (4)
  - Army training management system (rosters, training start/end, graduation status)
  - Reception battalion records (rosters and demographics)
  - Defense Medical Surveillance System (medical encounters)
  - Accessions and Medical Standards Analysis & Research Activity (aggregated medical board results)

Methods (2 of 4)

Bone Stress Injury (BSI) Surveillance Definition

- **BSI definition**: overuse injuries associated with repeated loading of bone by strenuous weight-bearing activities (e.g., running, jogging, marching)
- Injury Prevention Branch used standardized diagnosis codes to identify all medical encounters for Bone Stress Injury (BSI)
  - ICD-10-CM[1] codes M84.30– M84.38XS
- **BSI case definition**: trainee with either:
  - One inpatient encounter with BSI diagnosis, or
  - ≥2 outpatient encounters with BSI diagnosis within 7 – 90 days
- **BSI surgery case definition:** BSI case with surgical intervention at BSI location
  - ICD-10 PCS[2] and CPT[3] codes indicating type and anatomic location of surgery

[1]ICD-10-CM: International Classification of Diseases, Tenth Revision, Clinical Modification
[2]ICD-10 PCS: Procedure Coding System
[3]CPT: Current Procedural Terminology

Methods (3 of 4)

BSI Metrics

- Injury outcomes (reported by sex and basic training site)
  - BSI incidence (percentage of trainees with ≥1 BSI): ((# BSI cases/total # trained)x100)
  - BSI rate: # BSI cases per 1,000 trainees per month (mo)
  - Percentage of BSIs by location: ((# BSI by location/total # BSI cases)x100)
  - Percentage of BSI cases that graduated: ((# BSI cases graduated/total # BSI cases)x100)
  - BSI rate ratio (female's rate/male's rate): RR (F/M), 95% confidence interval [CI])
  - χ^2 test of proportions (p-value) to compare equality of proportions
    - ✓ $\alpha \leq 0.05$ was set *a priori*

Methods (4 of 4)

BSI ICD-10-CM Diagnosis Codes

ICD-10 Codes	ANATOMIC LOCATION
M84.30X*	Unspecified site
M84.311* – M84.319*	Shoulder (right, left, unspecified)
M84.321* – M84.329*	Humerus (right, left, unspecified)
M84.331* – M84.332*	Ulna (right, left)
M84.333* – M84.334*	Radius (right, left)
M84.339*	Unspecified ulna and radius
M84.341* – M84.343*	Hand (right, left, unspecified)
M84.344* – M84.346*	Fingers (right, left, unspecified)
M84.350*	Pelvis
M84.351* – M84.353*	Femur (right, left, unspecified)
M84.359*	Hip (unspecified)
M84.361* – M84.362*	Tibia (right, left)
M84.363* – M94.364*	Fibula (right, left)
M84.369*	Unspecified Tibia & Fibula
M84.371* – M84.373*	Ankle (right, left, unspecified)
M84.374* – M84.376*	Foot (right, left, unspecified)
M84.377* – M84.379*	Toes (right, left, unspecified)
M84.38X*	Other site

Considerations Using BSI Codes:

- Insufficient central guidance for providers to select appropriate BSI ICD-10 codes
- Codes do not identify specific location of BSI within a bone
- Providers use different codes on subsequent encounters for the same injury
- Unable to identify the number of different BSIs per individual

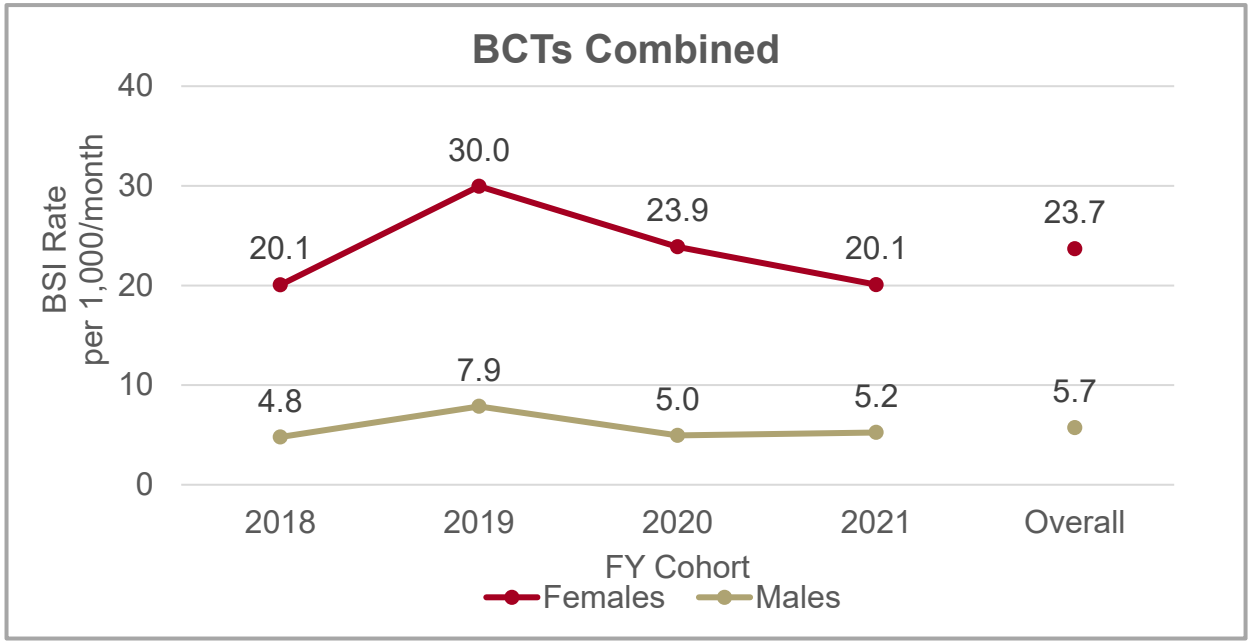
* Indicates that all 7th character codes (i.e., A, D, G, K, and P) are included for BSI routine healing, delayed healing, nonunion, and malunion of BSI

Results – BSIs during Basic Combat Training, FY 18–21 Cohorts

BSI Incidence and Rates by Sex, FYs 18–21 BSI Case Definition: ≥2 Outpatient Encounters

	Fiscal Year	Total Trainees		Trainees with a BSI		BSI Rate (BSI per 1,000/mo)		Rate Ratio (Females/Males)
		Females n	Males n	Females n (%)	Males n (%)	Females	Males	
Overall 2018–2021	2018	18,695	56,205	869 (4.6)	626 (1.1)	20.1	4.8	4.19 (3.78–4.64)
	2019	20,385	53,922	1,416 (6.9)	982 (1.8)	30.0	7.9	3.81 (3.51–4.13)
	2020	19,038	49,177	1,078 (5.7)	572 (1.2)	23.9	5.0	4.82 (4.36–5.33)
	2021	17,557	49,094	823 (4.7)	600 (1.2)	20.1	5.2	3.83 (3.44–4.25)
	Total	**75,675**	**208,398**	**4,186 (5.5)**	**2,780 (1.3)**	**23.7**	**5.7**	**4.14 (3.94–4.34)**

BSI Case Rates by Sex, and Year FYs 18–21 and Overall

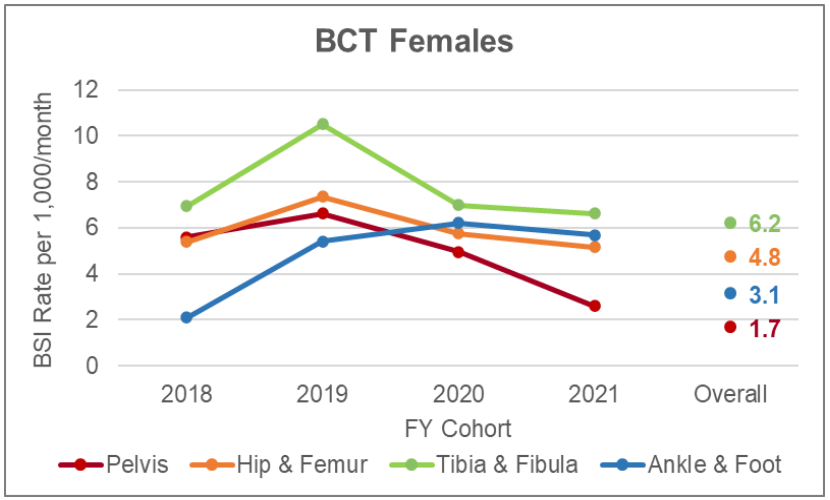


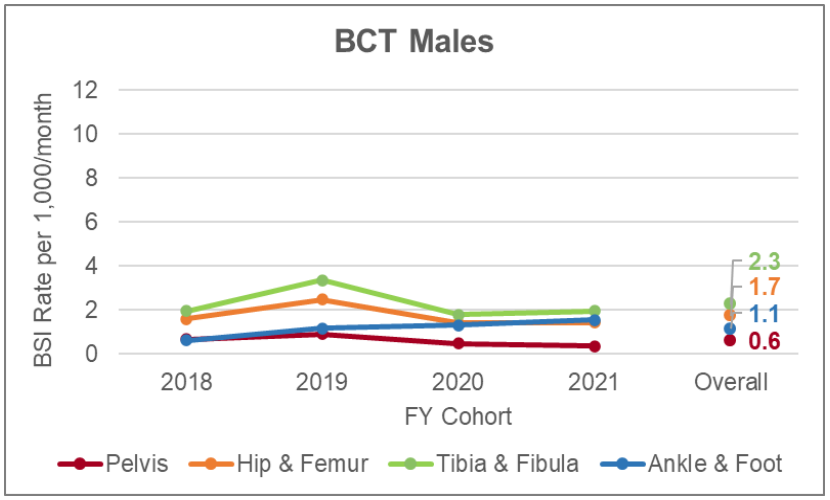
Rate Ratio (F/M)	
2018	4.19 (3.78–4.64)
2019	3.81 (3.51–4.13)
2020	4.82 (4.36–5.33)
2021	3.83 (3.44–4.25)
Overall	4.14 (3.94–4.34)

BSI Incidence and Rates by Sex, FYs 18–21 BSI Case Definition: ≥2 outpatient encounters

- Overall, FYs 18–21, 5.5% of female trainees (n=4,186) and 1.3% of male trainees (n=2,780) had at least one BSI (BSI case) during BCT
- Overall, female BSI case rate was 4 times higher than the rate for males
  - Female rate: 24/1,000/month (RR [F/M]: 4.14 (3.94–4.34))
  - Male rate: 6/1,000/month
- BSI case rates for both genders varied by year:
  - Sex-specific BSI case rates for the FY 19 cohort were higher compared to the FY 18 cohort overall
  - Overall, BSI case rates trended downward from FY 19 to FY 21 cohorts

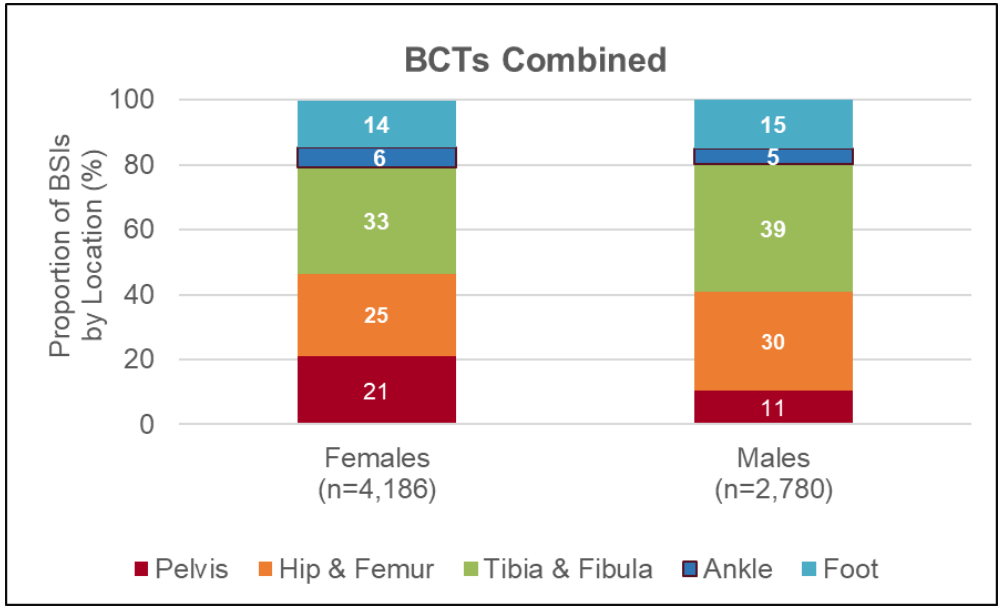
BSI Rates by Body Region, Sex, and Year[1,2] BCTs Combined, FYs 18–21 and Overall





Notes:
[1]Figures do not include BSIs with body region "upper extremity," "other," or "unspecified"; females: n=6, males: n=3
[2]The y-axis scale on these figures is 0 to 12 BSI per 1,000/month to show differences among rates by body region.

Proportion of BSIs by Body Region, and Gender[1] FYs 18–21 Overall



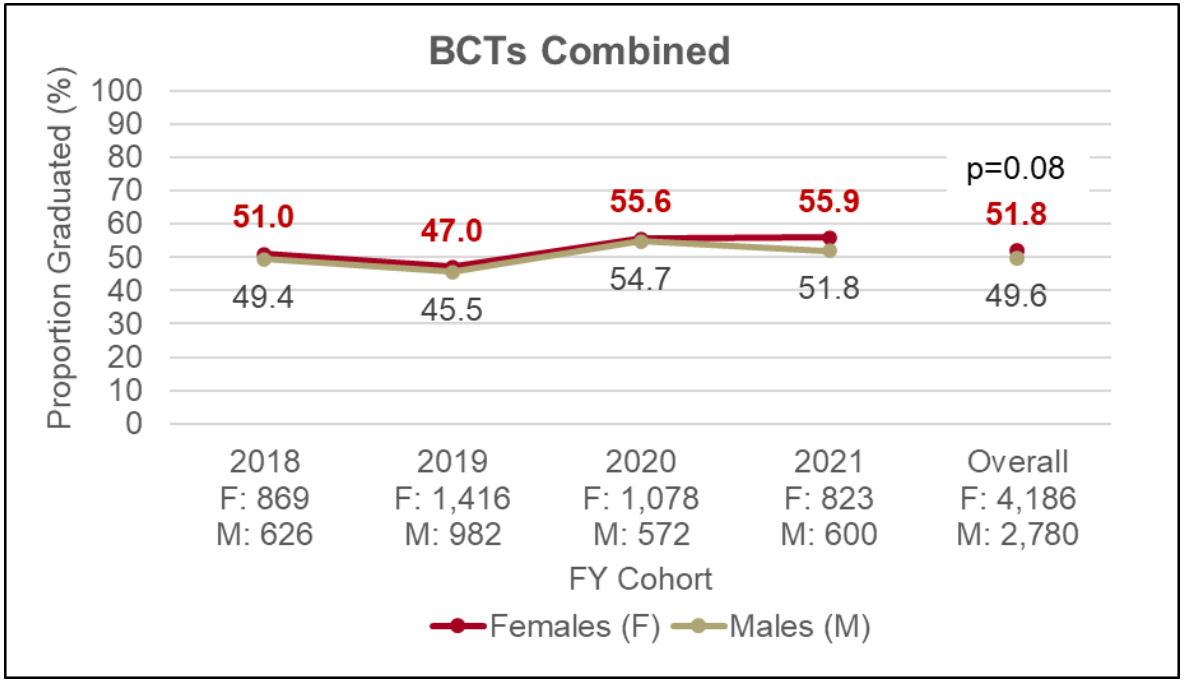
Note:
[1]Other and unspecified BSIs are not included in figures: Totals: females n=6; males: n=3 in BCTs combined

BSIs by Body Region and Sex during BCT FYs 18–21 and Overall

- BSI rates by body region generally followed the same patterns as the overall BSI rates – highest for FY 19 cohort, then decreasing for FYs 20–21 cohorts
- BSI rate for the tibia-fibula tended to be higher compared to other body regions for both genders
- Overall, a larger proportion of female BSIs involved the pelvis (21%) compared to males (11%); $p<0.001$
- Overall, larger proportions of male BSIs involved the “hip & femur” (30%) and “tibia & fibula”(39%) compared to females (25% and 33%, respectively); $p<0.001$ for each body region

Training and Medical Outcomes of BSI Cases during U.S. Army Basic Combat Training (BCT), FYs 18 –21

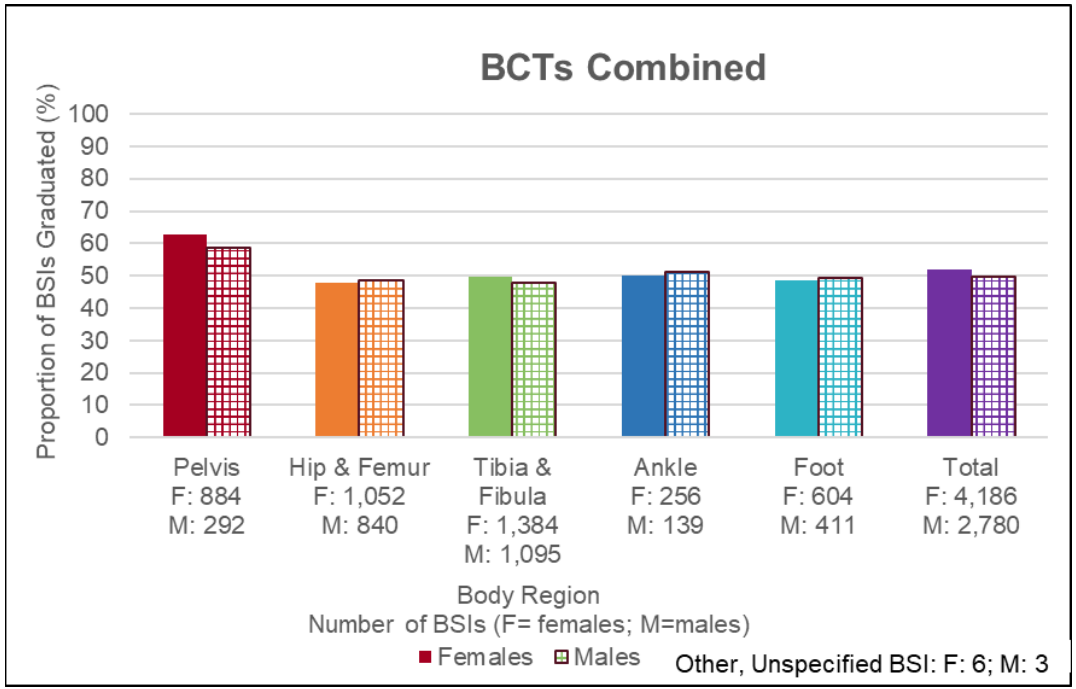
Graduation of BSI Cases by Sex and Year[1,2] FYs 18–21 and Overall



- Similar percentages of female and male BSI cases graduated BCT overall

Notes:
[1]Numbers on the x-axis for females (F) and males (M) represent the total number of BSI cases by FY cohort
[2]p-values for "overall" compare graduation between genders for FYs 18–21 overall

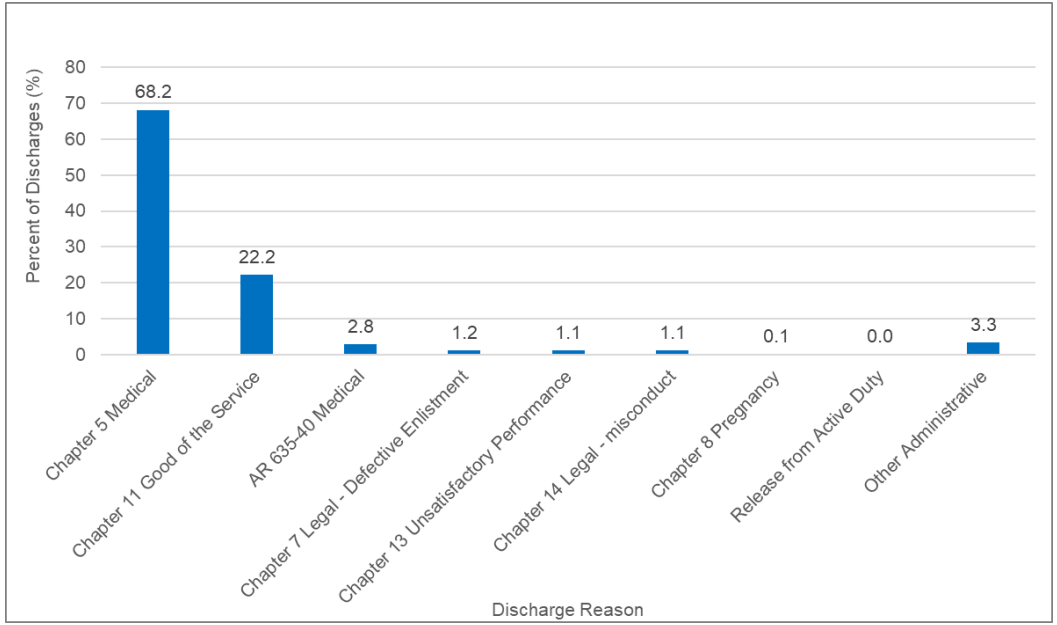
Graduation by BSI Body Region, and Gender[1] FYs 18–21 Overall



- No statistical difference between males and females that graduated by BSI body region

Note:
[1]Numbers on the x-axis for females (F) and males (M) represent the total number of BSI surgery cases by body region

Reason for BSI Discharges from BCT FYs 18–21 Overall



- ATRRS reason codes
  - 2,595 BSI cases had a ATRRS discharge reason code
  - AR 635-40 disability evaluation: n=73 (2.8% of discharges)
- Data provided by AMSARA
  - Of 3,613 BSIs discharged during BCT, 116 (3.2%) had a medical board finding for musculoskeletal disability
  - Of the 116, 91 received severance pay

ATRRS = Army training management system
AMSARA = Accessions and Medical Standards Analysis & Research Activity

Training Outcomes of BSI Cases during BCT
Graduation of BSI Cases, FYs 18–21

- Proportion of BSI cases that graduated increased for both genders from the FY 18 cohort to FY 21 cohort (overall, and at each training center)
- Overall, proportions of female and male BSI cases that graduated were not statistically different (overall BCT: p=0.08)
- BSI body region was not a statistically significant risk factor for graduation between females and males

BSI Surgery Case Rate by Gender
FYs 18–21 Overall

FY Cohort	Total BSI Cases		Total BSI Case Rate (BSI per 1,000/mo)		BSI Cases with Surgery during BCT		BSI Surgery Case Rate (Surgery per 1,000/mo)	
	Females n	Males n	Females	Males	Females n (%)	Males n (%)	Females	Males
Overall 2018–2021	4,186	2,780	23.8	5.7	96 (2.3)	107 (3.8)	0.54	0.22

- Overall, BSI surgery rate for females is 2.5 times higher than the rate for males (RR (F/M): 2.46 (1.87–3.25); p<0.001)

Medical Outcomes of BSIs Cases during BCT
BSI Surgery Cases, FYs 18–21 Overall

- BSI surgeries
  - Among trainees with a BSI (F: 4,186; M: 2,780), 2.3% of females (n=96) and 3.8 % of males (n=107) required surgical intervention
  - Overall BSI surgery rates were 0.54/1,000/month for females and 0.22/1,000/month for males; Rate Ratio (F/M): 2.46 (1.87–3.25); p<0.001)
  - BSIs of the “hip and femur” accounted for 94% and 88% of surgeries among females and males, respectively

Graduation of BSI Surgery Cases by Gender FYs 18–21 Overall

FY Cohort	All BSI Cases, Graduated BCT		Total BSI Case Rate (BSI per 1,000/month)		BSI Cases with Surgery Graduated	
	Females n (%)	Males n (%)	Females n (%)	Males n (%)	Females n (%)	Males n (%)
Overall 2018–2021	2,168 (51.8)	1,380 (49.6)	2,135 (52.2)	1,335 (49.9)	33 (34.4)	45 (42.1)

- 34% of females BSI surgery cases graduated BCT compared to 52% of female BSI cases without surgery ($p<0.001$)
- Among male BSI cases, graduation was not statistically different for those with and without surgery ($p=0.11$)

Follow-up of BSI Cases 1–60 Days after Graduation by Gender[1], FY 21 and FYs 18–21 Overall

FY Cohort	Trainng Center	BSI Cases Graduated BCT		≥1 F/U BSI Med. Visit 1–60 Days after Graduation		Surgery 1–60 Days after Graduation		Discharged 1–60 Days after Graduation	
		Females n	Males n	Females n (%)	Males n (%)	Females n	Males n	Females n	Males n
Overall 2018–2021	2018	443	308	205 (46.3)	97 (31.5)	2	0	0	2
	2019	665	445	352 (52.9)	167 (37.5)	3	1	3	2
	2020	599	313	289 (48.2)	122 (39.0)	3	2	10	4
	2021	460	311	207 (45.0)	97 (31.2)	3	0	4	5
	Total	**2,167**	**1,377**	**1,053 (48.6)**	**485 (35.2)**	**11**	**3**	**17**	**13**

Note:
[1]Outcomes 1–60 days after BSI cases graduated from BCT (i.e., outcomes during AIT)

- FYs 18–21 combined, 49% of female and 35% of male BSI cases from BCT had at least one medical encounter for BSI 1–60 days after graduation (AIT)
  - **1–14 days**: F: 372; M: 209; **15–30 days**: F: 413; M: 242; **31–61 days**: F: 470; M: 406
- 11 female and 3 male BSI cases had surgery 1–60 days after graduation
- 17 female and 13 male BSI cases from BCT were discharged 1–60 days after graduation

New (1st) BSI Cases 1–60 Days after BCT Graduation (AIT)[1] FY 21 and FYs 18–21 Overall

FY Cohort	Fiscal Year	New BSI Case 1-60 Days after Graduation		BSI Surgery 1–60 Days after Graduation	
		Females n (%)	Males n (%)	Females n	Males n
Overall 2018–2021	2018	303 (1.6)	182 (0.3)	9	2
	2019	382 (1.9)	255 (0.5)	7	3
	2020	301 (1.6)	229 (0.5)	12	3
	2021	269 (1.5)	190 (0.4)	9	6
	Total	**1,255 (1.7)**	**857 (0.4)**	**37**	**14**

Note:
[1] BCT trainees with no BSI medical encounter during BCT, but were a BSI case within the first 60 days after graduation (AIT)

Body Region of New BSI Cases

Body Region	Females n (%)	Males n (%)
Pelvis	247 (19.9)	45 (5.3)
Hip & Femur	480 (38.7)	239 (28.1)
Tibia & Fibula	386 (31.1)	434 (51.1)
Ankle & Foot	128 (10.3)	132 (15.5)
Total	**1,241**	**850**

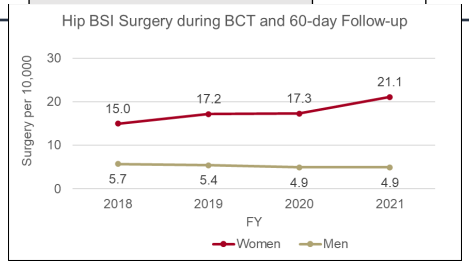
Body Region for BSI Surgery Cases

Body Region	Females n (%)	Males n (%)
Hip & Femur	33 (89.2)	12 (85.7)
Tibia & Fibula	4 (10.8)	1 (7.1)
Ankle & Foot	–	1 (7.1)
Total	**37**	**14**

- FYs 18–21 combined, there were 1,255 female and 857 male new BSI cases within the first 60 days after BCT graduation (not a BSI case during BCT)
  - 37 females and 14 males required BSI surgery (hip & femur: F=33; M=12)

Hip BSI Surgery Cases during BCT and 60-day Follow-up FYs 18–21 and Overall

Time Frame	Women						Men					
	FY 18	FY19	FY20	FY21	Overall FY18–FY21		FY 18	FY19	FY20	FY21	Overall FY18–FY21	
	n	n	n	n	n	per 10,000 trainees	n	n	n	n	n	per 10,000 trainees
During BCT	18	25	21	26	90	**11.9**	30	24	20	20	94	**4.5**
1–60 days after BCT (AIT)	10	10	12	11	43	**5.7**	0	1	2	0	15	**0.7**
BCT plus 60 days	28	35	33	37	133	**17.6**	32	29	24	24	109	**5.2**



Summary – BSI Cases at during BCT, FYs 18–21 Cohorts

- Overall (FY 18–21 cohorts), 5.5% of female (n=4,186) and 1.3% of male trainees (n=2,780) had at least one BSI (BSI case) during BCT
- An additional 1.7% of female (n=1,255) and 0.4% of male trainees (n=857) had a BSI within 60 days after graduation
- Overall (FY 18–21 cohorts), the female BSI case rate was 4 times higher than the male rate
  - Female rate: 24/1,000/month (RR [F/M]: 4.14 (3.94–4.34))
  - Male rate: 6/1,000/month

Summary – BSI Cases at during BCT, FYs 18–21 Cohorts

- Since the FY 18 cohort, BSI case graduation trended higher for both genders
- Overall (FY 18–21 cohorts), number of BCT BSI surgery cases was 96 for females and 107 for males (2.3% of all female BSI cases and 3.8% of all male BSI cases had surgery)
  - Overall, BSI surgery case rates were 5.4 and 2.2 per 10,000/month (females and males, respectively)
  - Overall, total number of hip BSI surgery cases was 90 for females (5.1 per 10,000/month) and 94 for males (1.3 per 10,000/month)
- Of BSI cases that graduated BCT (FY 18–21 cohorts), 49% of female cases and 35% of male cases had ≥1 BSI medical encounter during AIT (1–60 days) (11 females and 3 males had BSI surgery)

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