REPORT DOCUMENTATION PAGE

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1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
18-01-2018	Public Health Report	1 Oct 2016 - 31 Dec 2017

4. TITLE AND SUBTITLE
Injury Surveillance and Longitudinal Studies for Gender Integration in the Army, Second Annual Assessment, 2017

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Keith G. Hauret, Michelle Canham-Chervak, Anna Schuh-Renner, Esther O. Dada, Bonnie J. Taylor, Joseph R. Pierce, Bruce H. Jones

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Injury Prevention Division, U.S. Army Public Health Center, Aberdeen Proving Ground, MD

8. PERFORMING ORGANIZATION REPORT NUMBER
PHR No. S.0047783-17

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The purpose of this report is to provide an annual update summarizing the injury surveillance, longitudinal studies, and injury mitigation program evaluations conducted by the U.S. Army Public Health Center (APHC) Injury Prevention Division (IPD) during implementation of the Army's gender integration plan. This report summarizes: (1) findings from injury surveillance of the operational Army Active Component (CY2016) and Initial Entry Training (IET: Basic Combat Training (BCT), One Station Unit Training (OSUT), and Advanced Individual Training (AIT)) from 2011 to 2016; (2) causes of injury among trainees in IET and officers in Basic Officer Advanced Courses; (3) evaluation of the association of Occupational Physical Assessment Test (OPAT) performance, injuries, and graduation among BCT trainees (3 January to 9 June 2017); and (4) evaluation of the Multivitamin with Iron Program for Women in IET as potential mitigation to reduce the injury and attrition risks among women.

15. SUBJECT TERMS
injury surveillance, gender integration, Basic Combat Training (BCT), One Station Unit Training (OSUT), Advanced Individual Training (AIT), Occupational Physical Assessment Test (OPAT), injuries

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Keith Hauret
U	U	U	UU	56	19b. TELEPHONE NUMBER *(Include area code)* 410-436-5291

U.S. Army Public Health Center

Public Health Report

PHR No. S.0047783-17
Injury Surveillance and Longitudinal Studies for Gender Integration in the Army
Second Annual Assessment, 2017

Approved for public release; distribution unlimited

General Medical: 500A

January 2018

APHC

ACKNOWLEDGEMENTS

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This research was supported in part by appointments to the Postgraduate Research Participation Program at the APHC and USARIEM administered by the Oak Ridge Institute for Science and Education through interagency agreements between the U.S. Department of Energy (DOE) and APHC, and the U.S. DOE and USARIEM.

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EXECUTIVE SUMMARY
Public Health Report No. S.0047783-17
Injury Surveillance and Longitudinal Studies for Gender Integration in the Army
Second Annual Assessment, 2017

1 Purpose

The purpose of this report is to provide an annual update summarizing the injury surveillance, longitudinal studies, and injury mitigation program evaluations conducted by the U.S. Army Public Health Center (APHC) Injury Prevention Division (IPD) during implementation of the Army's gender integration plan as described in HQDA Executive Order 097-16 (i.e., Army Implementation Plan 2016-01 [Gender Integration]) (HQDA, 2016b).

This report is the second annual report from APHC IPD. Specifically, the report summarizes: (1) findings from injury surveillance of the operational Active Army and Initial Entry Training (IET: Basic Combat Training (BCT), One Station Unit Training (OSUT), and Advanced Individual Training (AIT)) from 2011 to 2016; (2) causes of injury during Initial Military Training (IMT: enlisted AITs; officer Basic Officer Advanced Courses (BOLC)); (3) evaluation of the association of Occupational Physical Assessment Test (OPAT) performance with injuries and graduation among BCT trainees (3 January to 9 June 2017); and (4) evaluation of the Multivitamin with Iron Program for Women in IET as potential mitigation to reduce the injury and attrition risks among women.

2 Findings

2.1 Injury Surveillance of the Active Army and IET

The Army is a physically demanding profession with a spectrum of injury risks for each occupational field. Musculoskeletal injuries are one of the greatest challenges to Soldier and unit readiness, responsible for 55% of all medically nondeployable Soldiers (Office of the Surgeon General, personal communication, 2017). Historically, injury rates for female Soldiers have been higher than rates for male Soldiers in the Active Army and IET. These injury rates provide important information about the overall injury risks for Soldiers and differences in injury rates between the genders. In this discussion of injury rates for the Active Army, it must be recognized that these injury rates are for all women and men and are not limited to those women and men performing in the same occupational field or of the same rank, type of assignment or unit.

Overall, women in the operational Active Army have a 1.3 times higher injury rate compared to men. Enlisted women have a 1.4 times higher injury rate than enlisted men, and female officers have a 1.2 times higher injury rate than male officers. More reliable comparisons of injury rates by gender will require large numbers of women and men of similar rank in the same military occupational specialty (MOS) and with similar assignments.

During IET (i.e., BCT, OSUT, and AIT), large numbers of women and men perform the same training and are exposed to the same hazards and injury risks during training. For these reasons, IET provides a better comparison of injury rates for women and men than the

operational Active Army where training and injury risks can vary depending on rank, MOS, assignment, and type of unit.

Women in IET (i.e., BCT, OSUT (12B Combat Engineer and 31B Military Police) and the eight AITs that opened to women since 2013 have a higher injury rate compared to men than do women in the Active Army. In Fiscal Year 2016, injury rates for IET women were 2.0 to 2.1 times higher than rates for IET men. This is in consonance with BCT studies over the past 30 years, which have consistently reported injury rates that were twice as high for women compared to men. It remains to be seen how gender integration will influence injury rate differences among men and women in the operational Army.

2.2 Causes of Injury during IET

The APHC used self-reported survey data to identify the injury-related activities among Soldiers injured during AIT and BOLC. Among the enlisted AIT Soldiers, weight-bearing activities, such as running and marching or walking with a load, accounted for 60 percent to 70 percent of injuries. Running alone accounted for just over 40 percent of injuries for women and men. Among officers in BOLC, weight-bearing activities were also the leading activities associated with injuries, accounting for 55 percent to 59 percent of all injuries. Marching or walking with a load accounted for one-third of all injuries. To prevent injuries, distances run and amount of marching (miles marched and weight of loads carried) must be considered in developing training schedules that will produce desired fitness levels. Appendix B contains links to materials describing methods to prevent or reduce musculoskeletal injuries from physical training activities such as running and road marching.

2.3 Operational Physical Assessment Test (OPAT) Association with Injury and Attrition

As of 3 January 2017, new accessions are required to pass the OPAT at the physical demand level assigned to their MOS or area of concentration (AOC) (HQDA, 2016a). The OPAT ensures that Soldiers have the minimum level of physical fitness needed to perform the physically demanding tasks of their MOS/AOC. It is anticipated that the OPAT will have a secondary effect in reducing injuries and attrition. The APHC and the U.S. Army Training and Doctrine Command (TRADOC) Center for Initial Military Training (CIMT) completed a preliminary analysis of the OPAT among BCT Soldiers who began training after 3 January 2017 and graduated by 9 June 2017. Male Soldiers with Gray and Gold overall OPAT scores had a 1.2 times higher injury risk than men with Black OPAT scores. Female Soldiers with Gray OPAT scores had a 1.1 times higher injury risk compared to men who met the Black standard. BCT attrition was dependent on OPAT performance only among the men; men who met the lower Gray or Gold overall OPAT standard were 1.4 or 1.6 times more likely, respectively, to attrit during BCT.

2.4 Multivitamin with Iron (MVI): Evaluation of a Program for Women in IET

Based on prior studies showing positive effects of iron supplementation in military populations, the U.S. Army Medical Command (MEDCOM) and TRADOC collaborated to implement a new iron supplementation program. For 1 year beginning in September 2015, BCT and OSUT female trainees at Forts Leonard Wood, Jackson, and Sill were offered an MVI. The evaluation

showed a significant decrease in overall injury incidence among women who trained after the MVI Program was implemented compared to women who trained before the program started. A similar decrease was not observed among men in the same time frame. While it is possible that MVIs contributed to the decrease in injury incidence among women, the results should be interpreted with caution since MVI intake was not observed, and other factors such as variations in age or initial fitness levels could have influenced results.

3 Next Steps

These longitudinal studies and injury surveillance provide an historical baseline for the continuous assessment of injury rates, causes, and risk factors during gender integration. Given the strong association of lower levels of physical fitness and increased injury risk among Soldiers in the operational Active Army and during IET, it is imperative that the longitudinal studies and surveillance also monitor the physical fitness and performance of Soldiers. The APHC IPD and MEDCOM have identified several data gaps that may negatively affect the outcomes of future longitudinal surveillance and studies. It is imperative that the APHC IPD and MEDCOM work through the HQDA G-1 Integrated Longitudinal Studies Work Group and the Soldier 2020 Injury Rates/Attrition Rates Work Group and the Defense Health Agency to describe these data shortfalls and coordinate efforts to ensure data systems are improved or developed. Potential solutions are described in Section 10 of the report. Currently, data are limited or unavailable for the following:

- Duty status and causes of injury (i.e., injury-related activity and mechanism of injury) in electronic health records
- Days of limited duty and duty restrictions for injuries
- Performance data from the Army Physical Fitness Test
- OPAT Performance data for all new accessions
- Electronic medical encounters and duty/training dates for Army National Guard and Reserve

Future studies and injury surveillance by APHC IPD will expand to include the OSUTs opened to women in late FY17, the Infantry and Armor BOLCs, and longitudinal follow-up from IET to the first unit of assignment for Soldiers in combat occupational specialties. The APHC IPD will continue to assess the associations between OPAT scores, injury, and attrition in IET and beyond, as well as analyze cause of injury information gained from Army Research Institute for the Behavioral and Social Sciences surveys. Follow-up studies for the MVI Program for Women in IET are recommended, including multivariate analyses controlling for factors such as training site, component, age, and body mass index.

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1 REFERENCES

Appendix A provides the references cited within this document.

2 AUTHORITY

The U.S. Army Public Health Center (APHC) Injury Prevention Division (IPD) prepared this report according to APHC's responsibility under Army Regulation (AR) 40-5, Section 2-19 to provide support to U.S. Army Medical Command (MEDCOM) for comprehensive medical surveillance to identify, prevent, and control evolving health problems (Department of the Army, 2007). This annual assessment meets the requirement described in Headquarters, Department of the Army (HQDA) Execution Order (EXORD) 097-16 to the U.S. Army Implementation Plan 2016-01 (Army Gender Integration) for MEDCOM to provide annual assessments of longitudinal studies and injury surveillance (HQDA, 2016b).

3 INTRODUCTION

3.1 Purpose

The purpose of this report is to provide an annual update to HQDA summarizing the injury surveillance, longitudinal studies, and injury mitigation programs conducted by the APHC and MEDCOM during implementation of the Army's gender integration plan (i.e., Army Implementation Plan 2016-01 [Gender Integration]) (HQDA, 2016b).

3.2 Scope

Directives associated with this plan have been described in detail elsewhere (APHC, 2017b). This assessment describes results from the injury surveillance conducted by the APHC IPD for MEDCOM. These findings include injury rates and rate comparisons between genders for the operational Active Army and Initial Entry Training (IET) (i.e., Basic Combat Training (BCT), One Station Unit Training (OSUT), and eight Advanced Individual Training (AIT) courses that opened to women since fiscal year (FY) 2013). Reported injury rates include musculoskeletal (MSK) injuries for which Soldiers sought medical care, whether the injuries occurred on duty or off duty. Due to constraints imposed by available medical data, this report does not: (1) distinguish between injuries that occurred on-duty versus off-duty, (2) report limited duty time required to recover from injuries, or (3) report injury rates or causes for the Army National Guard or Reserve post-IET.

This annual assessment also includes summaries of non-surveillance activities conducted by APHC and MEDCOM for gender integration. These include: (1) results from surveys to identify injury-related activities during training, (2) the first longitudinal evaluation of the association of the Occupational Physical Assessment Test (OPAT) with injuries and attrition in BCT and

OSUT, and (3) evaluation of a potential injury mitigation program for women in IET, the Multivitamin with Iron (MVI) Program for Women in IET.

3.3 Background

On 10 March 2016, HQDA issued EXORD 097-16 to the Army Implementation Plan 2016-01 (Army Gender Integration) (HQDA, 2016b). By 1 April 2016, the Army was to execute its plan to open all occupations to qualified personnel regardless of gender. The EXORD described four phases, described in detail elsewhere (APHC, 2017b).

Defining the requirement for continuous assessment during gender integration, EXORD 097-16 describes five major lines of effort (paragraph 3C). The fifth line of effort is "Assessment." In this line of effort, MEDCOM is to work with HQDA G-1 and U.S. Army Training and Doctrine Command (TRADOC) to: (1) develop and implement surveillance studies to inform accessions and talent management decisions and (2) collaborate and coordinate studies with other Services to reduce resource requirements and identify best practices.

Paragraph 3D(5) of the EXORD specifically assigned the following tasks to MEDCOM:

- Injury Surveillance. Conduct surveillance of MSK injuries and provide annual reports to HQDA G-1 for the three Army components (i.e., Active, National Guard, and Reserve). Annual reports will include: (1) injury rates during the last 5 years for both genders in IET, including newly opened military occupational specialties (MOS) and the operational Army, (2) recommendations to mitigate injury rates, particularly in occupational fields requiring load-bearing activities, and (3) results of on-going studies on injuries and mitigation efforts.

- Longitudinal Studies. Support HQDA G-1 with results of longitudinal studies of MSK injuries that encompass medical aspects of physically demanding tasks, injury rates from duty performance, and injury prevention.

- OPAT Implementation Support. Support HQDA G-1 and TRADOC to implement the OPAT as a screening tool for new accessions.

4 ON-GOING INJURY SURVEILLANCE AND LONGITUDINAL STUDIES

The APHC IPD and MEDCOM have been actively engaged in the Army's plan for gender integration since 2013. A brief summary of current, ongoing activities follows:

- Injury Surveillance Assessments. The APHC IPD has primary responsibility for the Army's injury surveillance. It conducts routine, systematic injury surveillance of the operational (post-IET) Active Army and IET. The IET injury surveillance has continuously monitored injury rates and trends for trainees in the Active Army, National Guard, and Reserve during BCT, OSUT, and selected entry-level AIT courses since 2010. In 2013, the APHC IPD expanded this surveillance to include the six entry-level AITs that opened to women in FY 2013 (i.e., field artillery: 13M, 13P, and 13R; ordnance: 91A, 91M, and 91P). In 2016, the surveillance was again expanded to include two additional field artillery MOSs that began training women in FY

2016. This injury surveillance provides valuable historical baselines for injury rates and trends and will be the basis for comparing injury rates and trends during gender integration. The APHC IPD also administers surveys and conducts field investigations and program evaluations to identify injury risk factors and causes of injury in operational units and IET.

- OPAT and OPAT Longitudinal Validation Study. The U.S. Army Research Institute of Environmental Medicine (USARIEM), supported by TRADOC and APHC, conducted Phase I (IET phase) of the OPAT Longitudinal Validation Study during 2016. The purposes of this study phase were to validate the OPAT testing procedures in the IET setting and to identify appropriate cut-scores for the OPAT among trainees. Data collection for Phase I was completed in December 2016, and USARIEM and APHC briefed the results to the TRADOC Commanding General in January 2017. The APHC IPD will evaluate the longer-term relationships between the OPAT scores, APFT performance, and injuries by following the Soldiers enrolled in Phase I for the next 2 years.

- Longitudinal Analysis of the OPAT. All new enlisted accessions that began BCT and OSUT on or after 3 January 2017 were required to take the OPAT during the recruitment process and score/achieve at least the minimum OPAT category required for their MOS (HQDA, 2016a). In August 2017, APHC IPD supported the TRADOC Center for Initial Military Training (CIMT) in evaluating the association of the OPAT with injury and on-time graduation for all BCT and OSUT trainees who began training on or after 3 January 2017 and graduated by 9 June 2017. This evaluation included 16,924 BCT Soldiers from all four training centers and 5,557 OSUT Soldiers including all OSUTs at Forts Benning and Leonard Wood. A summary of this OPAT evaluation is included in this report.

- Multivitamin with Iron (MVI): Evaluation of a Program for Women in IET. In 2015, one of the recommendations from MEDCOM's Soldier 2020 Injury Rates/Attrition Rates Working Group was to provide a MVI to women in IET. Research has shown a significant decline in iron status among female military trainees in BCT. This decline is associated with decrements in physical and cognitive performance. Studies found that an MVI could significantly improve performance on the Army Physical Fitness Test (APFT) for women with low iron (McClung, 2016). MEDCOM worked with USARIEM and TRADOC to implement a program that provides an MVI to all female trainees at BCT and OSUT installations (HQDA, 2016c). This program rolled out sequentially at Forts Leonard Wood, Jackson, and Sill beginning in September 2015. The APHC IPD recently completed a preliminary evaluation of the program. Preliminary results are summarized in this report.

- Soldier Surveys. The APHC IPD is collaborating with the Army Research Institute for the Behavioral and Social Sciences (ARI) to include a series of injury-related questions in surveys administered by ARI to Soldiers at the end of their AIT or Basic Officer Leadership Course (BOLC) and in Army unit assessments. These surveys provide invaluable information on causes of injury (i.e., injury-related activities and mechanisms of injury) during gender integration that is not available from existing data systems. A summary of injury-related activities in AIT and BOLC is included in this report for surveys administered in 2016 and 2017.

5 INJURY SURVEILLANCE: METHODS AND FINDINGS 2011 to 2016

During all phases of gender integration, assessment of key indicators, outcomes, and metrics is critical. This assessment informs leaders and serves as a basis for adjusting or modifying aspects of the implementation plan. Among the key metrics being monitored are: (1) MSK injury rates and trends, (2) causes of injury, and (3) long-term effects of injuries on reclassification and attrition. The APHC IPD monitors these injury-related metrics through systematic injury surveillance of the operational Active Army and IET (BCT, OSUT, and the eight AITs that opened to women since FY 2013). The OSUT and eight AITs that opened to women since FY 2013 are presented in **Table 1**.

Table 1. OSUT and AITs Opened to Women Since FY 2013

MOS	IET Training Type	Title	Year Began Training Women
12B	OSUT	Combat Engineer	FY 2015
13B	AIT	Cannon Crewmember	FY 2016
13D	AIT	Field Artillery Automated Tactical Data System Specialist	FY 2016
13M	AIT	Multiple Launch Rocket System (MLRS) Crewmember	FY 2013
13P	AIT	MLRS Operations/Fire Detection Specialist	FY 2013
13R	AIT	Field Artillery Firefinder Radar Operator	FY 2013
91A	AIT	M1 Abrams Tank System Maintainer	FY 2013
91M	AIT	Bradley Fighting Vehicle System Maintainer	FY 2013
91P	AIT	Artillery Mechanic	FY 2013

Source: Army Training Requirements and Resources System (ATRRS), prepared by APHC IPD

5.1 Methods for Injury Surveillance by the APHC IPD

The APHC IPD's injury surveillance for the operational Active Army and IET relies primarily on the medical encounter data (i.e., outpatient clinic visits and hospitalizations) entered by medical providers in Soldiers' electronic health records. These medical encounter data are retrieved from the Defense Medical Surveillance System (DMSS) maintained by the Armed Forces Health Surveillance Branch (AFHSB) of the Defense Health Agency. Injury diagnosis and date of medical encounters (i.e., hospitalizations and outpatient clinic visits) are retrieved from the DMSS; however, other important details such as what caused the injury, whether the Soldier was on or off duty when the injury occurred, and number of limited duty days required are not available at the present time in the medical encounter data.

To conduct the injury surveillance for IET, the APHC IPD obtains rosters of Soldiers who trained in each BCT, OSUT, and AIT from the Army Training Requirements and Resources System (ATRRS). The ATRRS is the Department of Army Management Information system of record for managing student input to training.

Prior to FY 2016, the APHC IPD linked results of the APFTs administered to Soldiers during BCT, OSUT, and AIT to the injury-encounter data to evaluate the relationship between physical fitness and injury risk. These APFT data were accessed from TRADOC's Resident Individual Training Management System (RITMS). But in 2016, the Digital Training Management System (DTMS) replaced RITMS as the system of record for APFT and other training data. For a variety of reasons, APFT data for IET has not been accessible since the transition of RITMS to DTMS.

Injury surveillance findings are summarized in this section. Injury rates and trends are presented first for the operational (post-IET) Active Army and then for IET (i.e., BCT, OSUT, and the eight AITs that have opened to women). For both populations, injury rates are presented for 2016, the most recent year for which there is complete medical data; injury trends are presented for the period 2011 to 2016. The IET injury rates include Soldiers from all three Army components, but rates for the operational Army only include the Active Army. Medical and training data used in systematic surveillance are not available for the National Guard and Reserve after IET.

To understand the surveillance findings in this report, it is important to first define "injury" and the injury metrics that will be presented—

- Injury. 'Injury' in this report refers to physical damage to the body caused by application of external mechanical forces for which the Soldier sought medical care. Injuries are identified from diagnosis codes entered by medical providers and coders in the electronic health record. The set of injury-related diagnoses included in this report is based on the Installation Injury Report metric from the AFHSB. This metric includes predominantly MSK injuries. Major categories of MSK injuries are: (1) *overuse injuries* that occur gradually over time in response to low intensity, repetitive mechanical forces (e.g., Achilles tendonitis, "runner's knee," and bone stress injuries) and (2) *traumatic injuries* that occur after a sudden application of mechanical force or energy such as occurs when falling to the ground or being struck by an object or person.

- Injury Rate. 'Injury rate' is the number of injury occurrences per unit of time. In this report, injury rates for the operational Active Army are expressed with different units of time than rates for IET—

- *Operational Active Army*. Injury rates are expressed in terms of the "number of injuries per 1,000 person-years of training." For example, an injury rate of 1,500 per 1,000 person-years means there were 1,500 injuries among 1,000 Soldiers who each trained for 1 year.

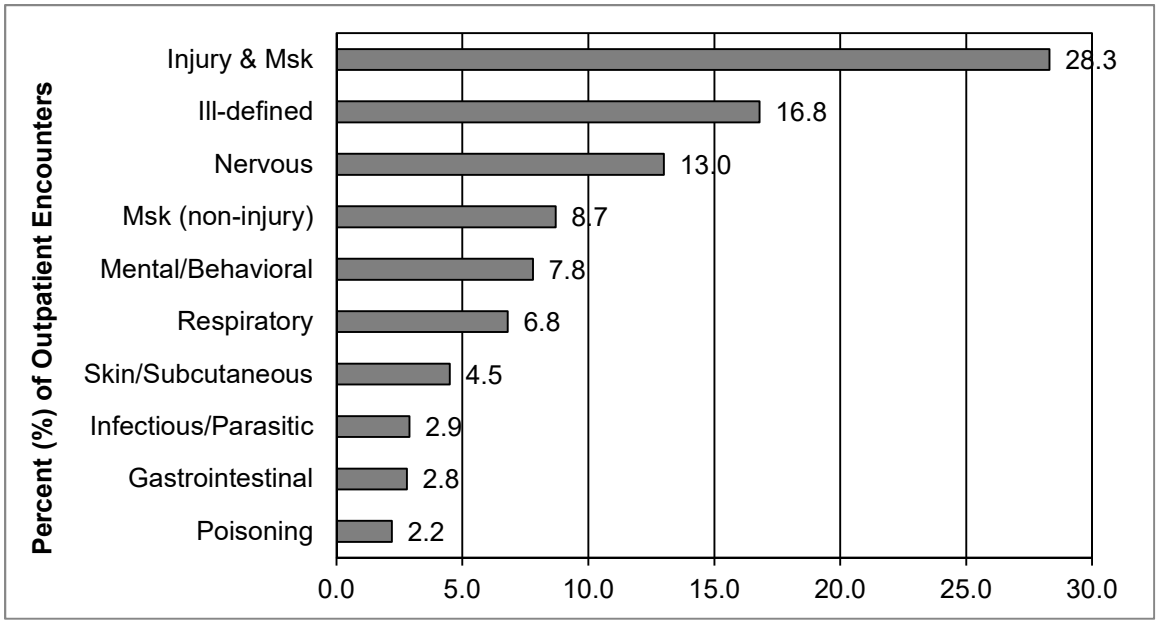
- *IET*. Injury rates for IET are expressed in terms of the "number of Soldiers who had one or more injuries during their training course per 100 person-months of training." For example, an injury rate of 10 per 100 person-months means that 10 Soldiers had at least one injury during 100 person-months of training. In BCT (10-weeks in duration), 100 person-months are equivalent to 40 Soldiers who each trained for 10 weeks (2.5 months).

- Injury Rate Ratio (Women:Men). The 'injury rate ratio' is calculated by dividing the injury rate for women (W) by the injury rate for men (M). For example: an injury rate ratio (W:M) equal to 1.5 indicates that the injury rate for women was 1.5 times higher than the rate for men.

5.2 Injury Rates for the Operational Active Army, Calendar Years (CY) 2011 to 2016

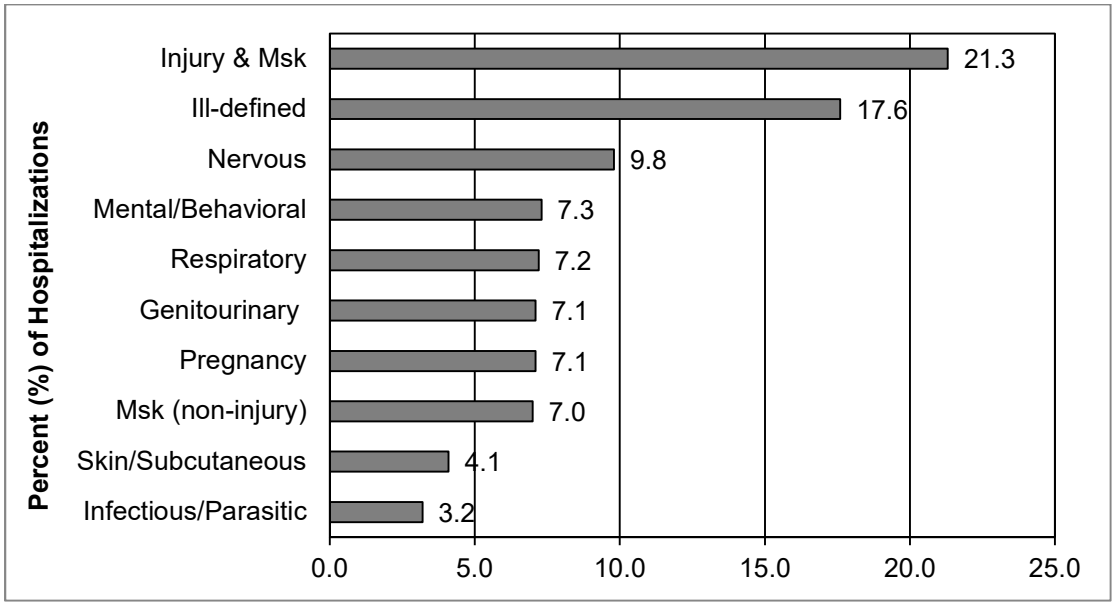
In comparing population injury rates for Active Army women and men, overall differences in injury risk by gender are evident. However, it must be recognized that these population-based comparisons include all women and men in the categories described below and include all injuries for which Soldiers sought medical care without regard for whether the injuries occurred on duty or off duty.

- Overall Active Army—Leading Diagnoses and Gender Comparisons, CY 2016. Over 99 percent of medical encounters among Active Duty military personnel occur in an outpatient setting (AFHSB, 2017). In CY 2016, the top three diagnosis categories for outpatient medical encounters among Active Army Soldiers were the same for both genders. For men (Figure 1) and women (Figure 2), injury was the leading diagnosis category, accounting for 21 percent all outpatient encounters for women (over 110,000 visits) and 28 percent of all outpatient encounters for men (over 490,000 visits). In 2016, 61 percent and 50 percent of all women and men, respectively, had at least 1 injury (APHC, 2017a).



Notes: Total number of incident outpatient visits = 1,731,583; Msk = Musculoskeletal
Source: DMSS, 2017; prepared by APHC IPD

Figure 1. Outpatient Medical Encounters by Major Diagnosis Groups for Active Army Men, CY 2016

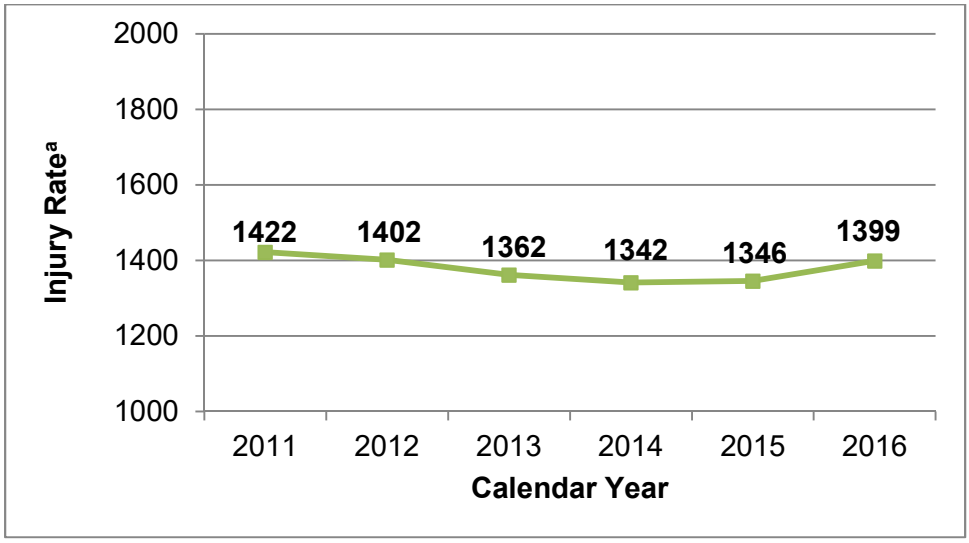


Notes: Total number of incident outpatient visits = 524,300; Msk = Musculoskeletal
Source: DMSS, 2017; prepared by APHC IPD

Figure 2. Outpatient Medical Encounters by Major Diagnosis Groups for Active Army Women, CY 2016

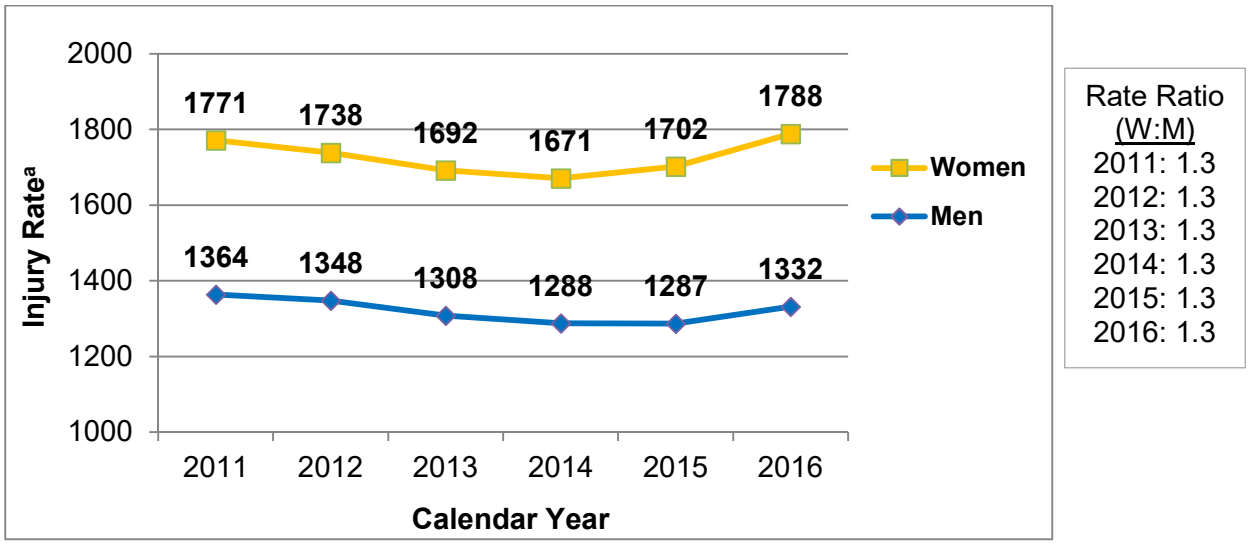
- Overall Active Army—Injury Rates and Gender Comparisons. MSK injuries in the operational Active Army affect over 280,000 Soldiers annually with many Soldiers having multiple injuries per year (APHC, 2017a). The overall injury rate for the Army in CY 2016 was 1,399 injuries per 1,000 person-years (APHC, 2017a). Injuries are one of the greatest challenges to Soldier and unit readiness, responsible for 55 percent of Soldiers who are medically nondeployable due to a temporary profile (Office of the Surgeon General, personal communication, 2017). The medically nondeployable information is based on an updated electronic profiling system (i.e., e-Profile) that was implemented in June 2016.

Figure 3 shows the annual injury rates (injuries per 1,000 person-years) for the Active Army, both genders combined. From CY 2011 to CY 2016, the annual injury rate decreased from 1,422 per 1,000 person-years to a low of 1,342 per 1,000 person-years in 2014. The rate increased in 2016 to 1,399 per 1,000 person-years but was still 2 percent lower than the rate in 2011. As shown in **Figure 4**, injury rates for both genders followed the same trend as the overall Army rates, increasing 1 percent for women and decreasing 2 percent for men over the 6-year period. Each year, the rate ratio (W:M) was 1.3, indicating that the injury rate for women was consistently 1.3 times, or 30%, higher than the rate for men.



Note: [a] Rate = Number of injuries per 1,000 person-years
Source: DMSS, prepared by APHC IPD

Figure 3. Annual Injury Rates[a] for the Active Army, CYs 2011 to 2016



Note: [a] Rate = Number of injuries per 1,000 person-years
Source: DMSS, prepared by APHC IPD

Figure 4. Annual Injury Rates[a] for Women and Men in the Active Army, CYs 2011 to 2016

5.3 Injury Rates by Functional Category of Occupational Specialties, CY 2016

The U.S. Army Human Resources Command (HRC) groups enlisted MOSs into the following three functional categories: Operations, Operations Support, and Force Sustainment (**Table 2**). Officer areas of concentration (AOC) are grouped into five functional categories, as follows: Army Special Operations Forces, Operations, Operations Support, Force Sustainment, and Health Services (**Table 3**) (Department of the Army, 2009; HRC, 2016a; HRC, 2016b).

It is useful to compare injury rates for the functional categories and by gender within each category to understand how injury risks vary for these large functional categories. However, it is also important to remember that each category includes a broad spectrum of MOSs or AOCs; Soldiers within any single MOS or AOC can have very different types of duties, assignments, and injury risks.

- Enlisted Functional Category Injury Rate Comparisons. **Table 2** presents 2016 injury rates for enlisted women and men in the functional categories. The overall injury rate ratio (W:M) of 1.4 indicates that the injury rate for women was 1.4 times higher than the rate for men, or 40 percent greater for women. Injury rates for both genders were lowest in the Operations category, but the injury rate ratio (W:M) was highest in this category (1.5).

Table 2. Injury Rates for Enlisted Soldiers by Functional Category, CY 2016

Enlisted Functional Categories[b]	Women	Men	Rate Ratio W:M
	Injury Rate[a]	Injury Rate[a]	
Operations[c]	1,655	1,135	1.5
Operations Support[d]	1,709	1,288	1.3
Force Sustainment[e]	1,758	1,402	1.3
Overall	1,740	1,269	1.4

Notes:
[a] Rate = Number of injuries per 1,000 person-years
[b] Functional categories defined using the HRC website (HRC, 2016a)
[c] Operations: 11, 13, 14, 15, 18, 19, 37, and 38
[d] Operations Support: 09, 12, 17, 25, 29, 31, 35, 46, and 74
[e] Force Sustainment: 27, 36, 42, 51, 56, 68, 79, 88, 89, 91, 92, and 94
Source: DMSS, prepared by APHC IPD

- Officer (Commissioned and Warrant) Functional Category Injury Rate Comparisons. **Table 3** presents CY 2016 injury rates for the officer functional categories. Injury rates for men were highest in the Force Sustainment category, while for women the highest rate occurred in the Operations Support category. The highest rate ratio (W:M) for women compared to men (1.3) occurred in the Operations category. Rate ratios (W:M) for women versus men across categories ranged from no difference (1.0) to a 30 percent greater risk among women (1.3).

Table 3. Injury Rates for Officers (Commissioned and Warrant) by Functional Category, CY 2016

Officer (Commissioned and Warrant) Functional Categories[b]	Women Injury Rate[a]	Men Injury Rate[a]	Rate Ratio W:M
Army Special Operations Forces	1,164	1,165	1.0
Operations[d]	1,166	916	1.3
Operations Support[e]	1,404	1,175	1.2
Force Sustainment[f]	1,400	1,246	1.1
Health Services[g]	1,136	920	1.2
Overall	1,241	1,034	1.2

Notes:
[a] Rate = Number of injuries per 1,000 person-years
[b] Functional categories defined using the HRC website (HRC, 2016b)
[c] Army special operation forces: 18, 37, and 38
[d] Operations: 02, 11, 12, 13, 14, 15, 19, 31, and 74
[e] Operations Support: 17, 24, 25, 26, 29, 30, 34, 35, 40, 46, 47, 48, 49, 50, 52, 53, 57, 59, and 94
[f] Force Sustainment: 01, 27, 36, 42, 51, 56, 88, 89, 90, 91, and 92
[g] Health Services: 05, 60, 61, 62, 63, 64, 65, 66, 67, 70, 71, 72, and 73
Source: DMSS, prepared by APHC IPD

- Officer versus Enlisted Gender-Based Injury Rate Comparisons. In all functional categories, injury rates are notably lower for officers, compared to enlisted. The overall injury rate for enlisted women was 40 percent higher than the rate for officer women, and the rate for enlisted men was 23 percent higher than for officer men. The overall rate ratio (W:M) for enlisted Soldiers was also higher than the rate ratio for officers (1.4 versus 1.2).

- Specific MOS and AOC Gender-Based Injury Rate Comparisons. **Table 4** presents injury rates for Active Army women and men in the enlisted MOS and officer AOC series that are included in the Army's gender integration plan. The enlisted MOSs are in the enlisted Operations functional category (**Table 2**); officer AOCs are in Operations and Special Operations functional categories (**Table 3**). It is useful to evaluate injury rates for MOS and AOC series to understand how injury risks vary even at this level of evaluation. However, it is also important to recognize that each MOS and AOC series is comprised of many occupational specialties, each having unique injury risks.

Table 4. Injury Rates for Army Occupational Specialties Most Affected by Gender Integration, CY 2016

	Enlisted			Officer (Commissioned and Warrant)		
	Women	Men	Rate Ratio	Women	Men	Rate Ratio
AOC/MOS	Injury Rate[a]	Injury Rate[a]	W:M	Injury Rate[a]	Injury Rate[a]	W:M
11 (Infantry)	--	1,073	--	[b]	815	--
12 (Engineer)	1,985	1,302	1.5	1,028	967	1.1
13 (Field Artillery)	1,826	1,188	1.5	981	915	1.1
18 (Special Forces)	--	1,132	--	--	1,190	--
19 (Armor)	--	1,171	--	[b]	849	--

Notes:
[a] Rate = Number of injuries per 1,000 person-years
[b] Injury rates not calculated for female Infantry and Armor Officers due to very few number of officers in these AOCs during CY 2016
Source: DMSS, prepared by APHC IPD

5.4 Injury Surveillance for IET

The APHC IPD implemented systematic unit-level injury surveillance of injuries during IET (i.e., BCT, OSUT, and AIT) in FY 2010. Findings from this ongoing systematic surveillance provide a valuable historical record for injury rates prior to gender integration and a basis for comparing injury rates during and after gender integration.

The IET injury surveillance summarized in this report includes the following:

- BCT at Forts Jackson, Leonard Wood, Sill, and Benning for FY 2011 through FY 2016. In FY 2016, 18,469 female trainees and 54,256 male trainees attended BCT. Fort Benning is the only BCT that was not gender integrated during this surveillance period.

- All OSUTs for FY 2011 through FY 2016 **(Table 5)**. The 12B Combat Engineer OSUT opened to women in FY 2015. The 12C Bridge Crewmember and 31B Military Police OSUTs trained women during the entire surveillance period FY 2011 to FY 2016 of this report. In FY 2016, a total of 1,978 female trainees and 27,440 male trainees attended OSUT.

Table 5. OSUTs Included in APHC Injury Surveillance and Number Trained in FY 2016

MOS	Title	Gender Integrated (as of FY 2016)	Women Trained n) (FY 2016)	Men Trained (n) (FY 2016)
11B	Infantryman	No	-	14,763
11C	Indirect Fire Infantryman	No	-	1,886
12B	Combat Engineer[a]	Yes	456	3,095
12C	Bridge Crewmember	Yes	103	350
19D	Cavalry Scout	No	-	2,527
19K	M1 Armor Crewmember	No	-	916
31B	Military Police	Yes	1,419	3,903
Total OSUT FY 2016			**1,978**	**27,440**

Note: [a]12B Combat Engineer OSUT began training women in FY 2015
Source: ATRRS, prepared by APHC IPD

- Eight Entry-Level AIT Courses for Enlisted MOSs that Began Training Women Since FY 2013. The numbers of Soldiers that attended these AITs in FY 2016, and from FY 2013 to FY 2016, are shown in **Table 6**. These AITs train relatively small numbers of Soldiers each year. Because of these small numbers, injury rates presented for FY 2016 will be overall rates including all eight of these AITs, combined.

Table 6. AITs Opened to Women Since FY 2013 and Number Trained, FY 2013 to FY 2016

MOS	Title	Women Trained (n)		Men Trained (n)	
		FY 2016	FY 2013 to 2016	FY 2016	FY 2013 to 2016
13B	Cannon Crewmember	120	120	2,149	4,084
13D	Field Artillery Auto.[a] Tactical Data System Spec.[a]	61	61	814	1,671
13M	MLRS[a] Crewmember	66	233	280	1,322
13P	MLRS Operations/Fire Detection Spec.[a]	34	175	127	796
13R	Field Artillery Firefinder Radar Operator	47	155	202	989
91A	M1 Abrams Tank System Maintainer	36	166	310	882
91M	Bradley Fighting Vehicle System Maintainer	18	193	179	933
91P	Artillery Mechanic	10	43	49	239
Total		**392**	**1,146**	**4,110**	**10,916**

Notes: [a] Abbreviations used in table: Automated (Auto.); Specialist (Spec.); MLRS
Source: ATRRS, prepared by APHC IPD

5.5 Injury Rates for BCT, OSUT, and Eight AITs Opened to Women, FY 2016

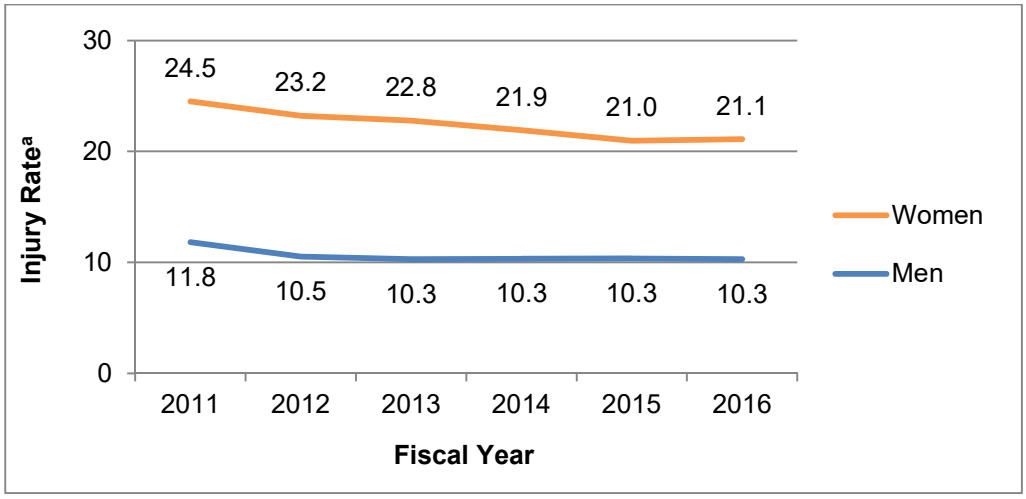
- BCT Injury Rates, FY 2016. **Table 7** provides the injury rates for BCT women and men at each of the BCT training centers. Injury rates for women ranged from 15 per 100 person-months at Fort Sill to 24 per 100 person-months at Fort Jackson. Rates for men ranged from 6 per 100-person months at Fort Sill to 13 per 100 person-months at Fort Benning. Additional studies are needed to identify factors that influence the range in injury rates by training center. The injury rate ratio (W:M) in BCT ranged from 2.0 to 2.4, indicating that BCT women have injury rates that are 2.0 to 2.4 times higher than rates for men.

Table 7. BCT Injury Rates and Rate Ratios by Post, FY 2016

BCT Post	Number Trained (n)		Injury Rate[a] (Injured per 100 person-months)		
	Women	Men	Women	Men	Rate Ratio (W:M)
Jackson	10,621	26,168	24.0	12.0	2.0 (1.5-2.8)
L. Wood	3,105	8,901	20.7	9.8	2.1 (1.5-2.9)
Sill	4,743	12,631	15.0	6.2	2.4 (2.3-2.5)
Benning	-	6,556	-	12.7	-
Overall	18,469	54,256	21.1	10.3	2.0 (2.0-2.0)

Note: [a] Injury rate = Soldiers injured per 100 person-months of training (Installation Injury Report metric)
Source: DMSS, prepared by APHC IPD

- BCT Injury Rates, FY 2011 to FY 2016. Annual BCT injury rates for both genders are shown in **Figure 5** for FY 2011 to FY 2016. From FY 2011 to FY 2015, there was a 14 percent decrease in the annual injury rate for women and a 12 percent decrease in the annual rate for men. The injury rate for both genders was unchanged from FY 2015 to FY 2016. The annual rate ratios (W:M) during this 6 year period ranged from 2.1 to 2.2. In other words, injury rates for women were 2.1 to 2.2 times higher than the injury rates for men.



Note: [a] Rate = Number of injured Soldiers per 100 person-months of training
Source: DMSS, prepared by APHC IPD

Figure 5. BCT Annual Injury Rates[a], FYs 2011 to 2016

- OSUT Injury Rates, FY 2016. Injury rates for each of the OSUT are presented in **Table 8**. Injury rates vary by OSUT type and gender. The 12B Combat Engineer OSUT that opened to women in FY 2015 had the highest injury rate for women. Among men, injury rates ranged from 6.8 per 100 person-months (31B Military Police) to 12.8 per 100 person-months (19D Cavalry Scout). Including only the OSUTs that trained women and men in FY 2016, the rate ratio (W:M) was 2.1, indicating that the injury rate for women was 2.1 times higher than the rate for men.

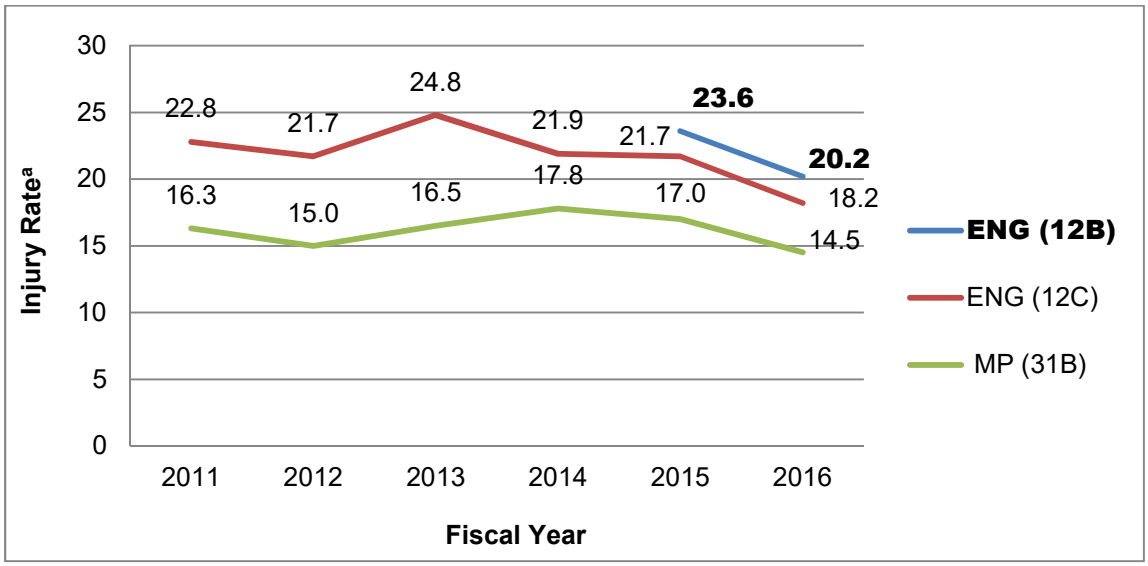
Table 8. OSUT Injury Rates and Rate Ratios, FY 2016

OSUT Type	Number Trained (n)		Injury Rate[a] (Injured per 100 person-months)		
	Women	Men	Women	Men	Rate Ratio (Women:Men)
11B Infantryman	-	14,763	-	11.0	-
11C Indirect Fire Infantryman	-	1,886	-	12.2	-
12B Combat Engineer	456	3,095	20.2	8.6	2.4 (2.3-2.4)
12C Bridge Crewmember	103	350	18.2	8.2	2.2 (2.1-2.3)
19D Cavalry Scout	-	2,527	-	12.0	-
19K M1 Armor Crewmember	-	916	-	12.6	-
31B Military Police	1,419	3,903	14.5	6.8	2.1 (2.1-2.2)

Note: [a] Injury rate = Number of Soldiers injured per 100 person-months of training (Installation Injury Report metric)
Source: DMSS, prepared by APHC IPD

- <u>OSUT Injury Rates, FY 2011 to FY 2016</u>.

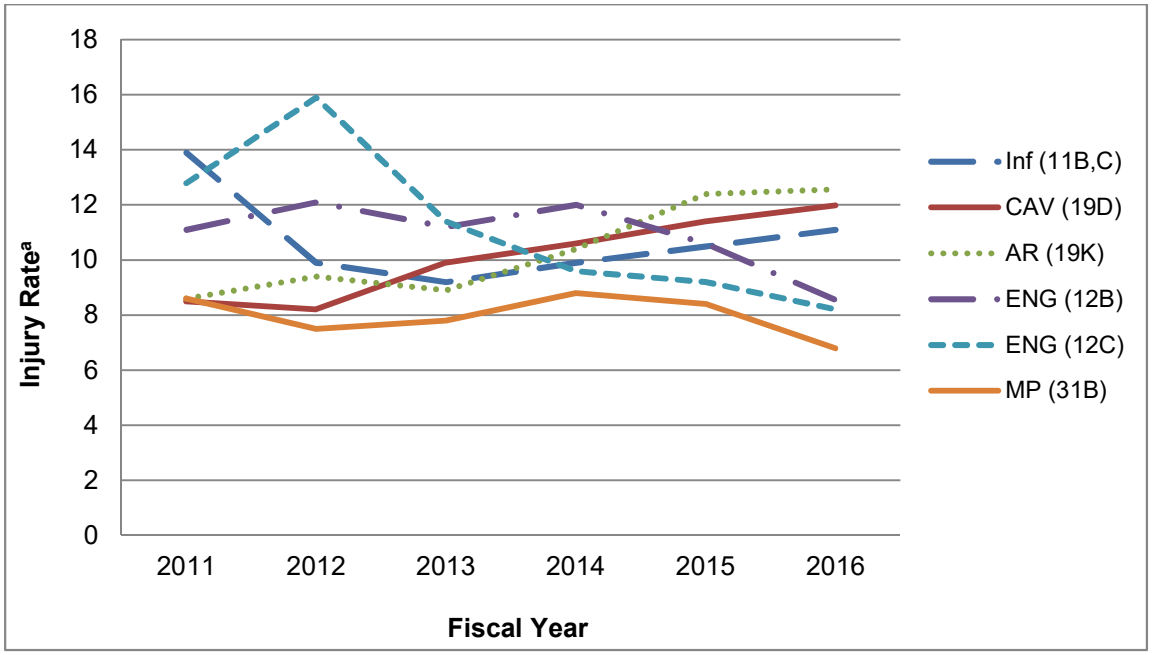
o *Women*. Annual injury rates for OSUT women are shown in **Figure 6** for FYs 2011 to FY 2016. Injury rates are presented for the 12C Bridge Crewmember and 31B Military Police OSUTs for all 6 years. Since women began training in the 12B Combat Engineer OSUT during the last quarter of FY 2015, only the FY 2015 and FY 2016 injury rates are shown (blue line; numbers in bold font). From FY 2013 to FY 2016, rates for the 12C Bridge Crewmember OSUT decreased 27 percent and rates for the 31B Military Police OSUT decreased 19 percent.



Notes:
[a] Rate = Number of injured Soldiers per 100 person-months of training
[b] OSUT for women: 12B Combat Engineers (opened to women in 2015), 12C Bridge Crewmember, and 31B Military Police
Source: DMSS, prepared by APHC IPD

Figure 6. OSUT Annual Injury Rates[ab] for Women, FY 2011 to FY 2016

o *Men*. Annual injury rates for OSUT men are shown in **Figure 7** for FY 2011 to FY 2016. Since FY 2014, the injury rates for the 12B Combat Engineer, 12C Bridge Crewmember, and 31B Military Police OSUTs decreased while rates for the 11B/C, 19D, and 19K increased. Additional study is needed to identify factors that have affected these increasing injury rates in the Fort Benning OSUTs.



Note: [a] Rate = Number of injured Soldiers per 100 person-months of training
Source: DMSS, prepared by APHC IPD

Figure 7. OSUT Annual Injury Rates[a] for Men, FY 2011 to FY 2016

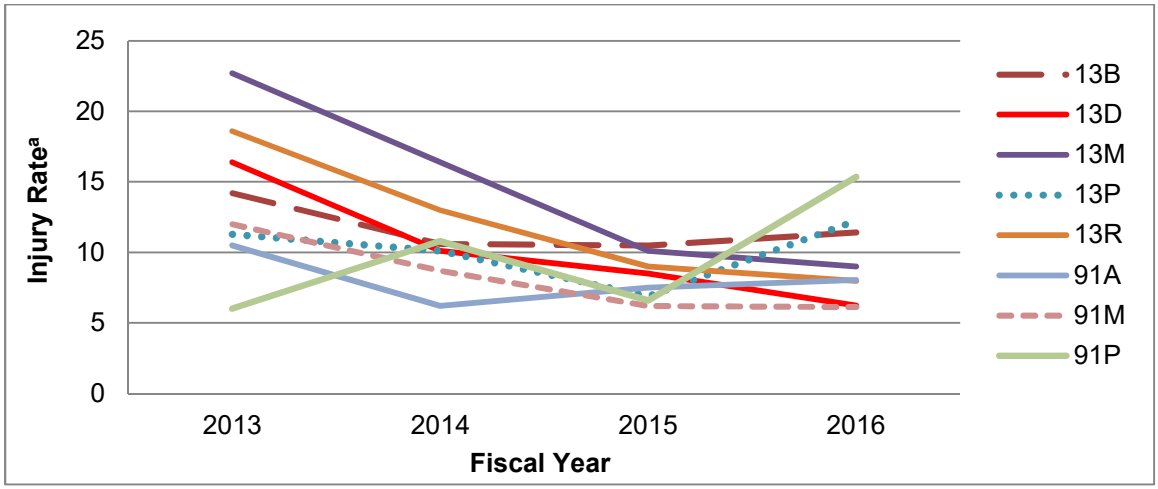
- AIT Injury Rates, FY 2013 to FY 2016. Overall injury rates for FY 2013 to FY 2016 are presented in **Table 9** for the eight AITs that began training women since FY 2013. Yearly rates for women in each MOS are not presented due to the small number of women trained each year. The AIT injury rates for women ranged from 13.7 (91A M1 Abrams Tank System Maintainer) to 32.0 per 100 person-months (13M MLRS Crewmember). Rates for men ranged from 7.6 (13D Field Artillery Automated Data system Specialist) to 13.6 per 100 person-months (13M MLRS Crewmember). The injury rate ratio (W:M) ranged from 1.7 to 2.5, indicating that injury rates for women were 1.7 to 2.5 times higher than rates for men.

Table 9. AIT Injury Rates and Rate Ratios, FY 2013 to FY 2016

AIT MOS	Number Trained (n)		Injury Rate[a] (Injured per 100 person-months)		
	Women	Men	Women	Men	Rate Ratio (W:M)
13B[a]	120	4,084	25.3	11.2	2.3 (2.2-2.3)
13D[a]	61	1,671	18.6	7.6	2.5 (2.4-2.5)
13M	233	1,322	32.0	13.6	2.4 (2.3-2.4)
13P	175	796	22.9	9.6	2.4 (2.3-2.5)
13R	155	989	19.7	11.0	1.8 (1.7-1.9)
91A	166	882	13.7	8.0	1.7 (1.7-1.8)
91M	193	933	18.2	8.7	2.1 (2.0-2.2)
91P	43	239	15.6	9.0	1.7 (1.7-1.8)
Overall	1,146	10,916	19.7	9.7	2.0 (2.0-2.0)

Notes:
[a] Rate = Number of injured Soldiers per 100 person-months of training
[b] 13B and 13D opened to women in FY16; 13B &13D injury data is for FY16
Source: DMSS, prepared by APHC IPD

Annual rates for AIT men are shown in **Figure 8** for FYs 2013 to 2016. The annual injury rates for these AITs vary widely. The annual rates for the 13D Field Artillery Automated Tactical Data System Specialist, 13M MLRS Crewmember, and 13R Field Artillery Firefinder Radar Operator were much higher in 2013 compared to the other MOSs. However, by FY 2015, the rates for these AITs decreased and were similar to the rates of the other MOSs. The injury rate for men increased from FY 2015 to FY 2016 for the 13P MLRS Operations/Fire Detection Specialist and 91P Artillery Mechanic, but remained more constant for the other AITs.



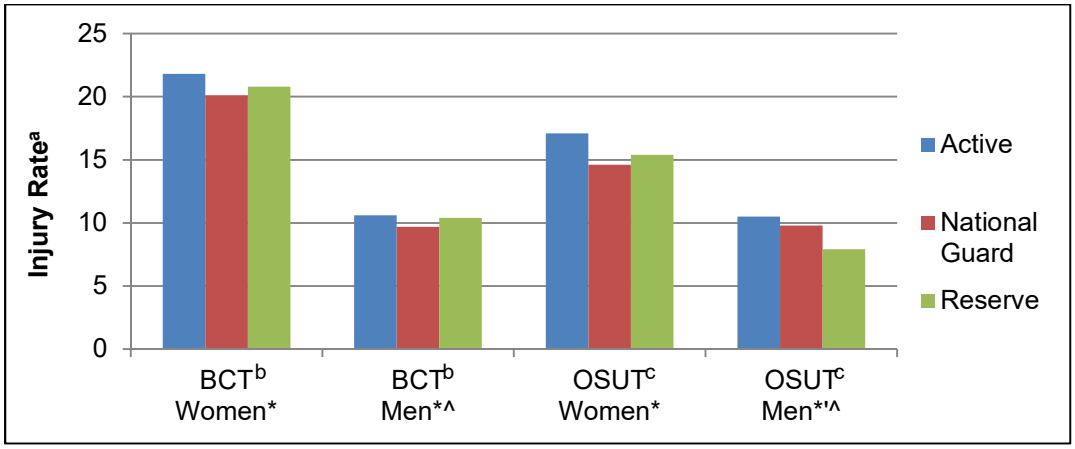
Note: [a] Rate = Injured Soldiers per 100 person-months of training

Figure 8. AIT Annual Injury Rates[a] for Men, FY 2013 to FY 2016

5.6 Injury Rates in IET by Army Component, FY 2016

The IET injury surveillance includes Soldiers from all three Army components (Active Army, National Guard, and Reserve). Due to the operational mission of each component and the mix of MOSs required to support that mission, the number and proportion of all Soldiers in each component vary from BCT to the individual OSUTs and AIT courses.

The BCT and OSUT injury rates by component and gender are illustrated in **Figure 9**. Injury rates for the three components vary for both training types and both genders. Differences in the rates by component that are significantly different are noted in Figure 12 and the footnotes.



Notes:
[a] Rate = Number of injured Soldiers per 100 person-months of training
[b] BCT Women: Forts Jackson, Leonard Wood, and Sill
[b] BCT Men: Forts Jackson, Leonard Wood, Sill, and Benning
[c] OSUT Women: 12B/C and 31B
[c] OSUT Men: 11B/C, 12B/C, 19D, 19K, and 31B
* Indicates significant difference (p<.01) Active component compared to National Guard
' Indicates significant difference (p<.01) Active component compared to Reserve
^ Indicates significant difference (p<.01) National Guard compared to Reserve

Figure 9. Injury Rates[a] by Component in BCT[b] and OSUT[c] by Army Component, FY 2016

Table 10 shows the number of women and men from each component that trained in FY 2016 in the eight AITs that opened to women since FY 2013. No Reservists trained in these AITs. Among women, the injury rate for the Active Army was 1.6 times higher than the rate for in the National Guard. The injury rates for men in the Active component and National Guard were the same.

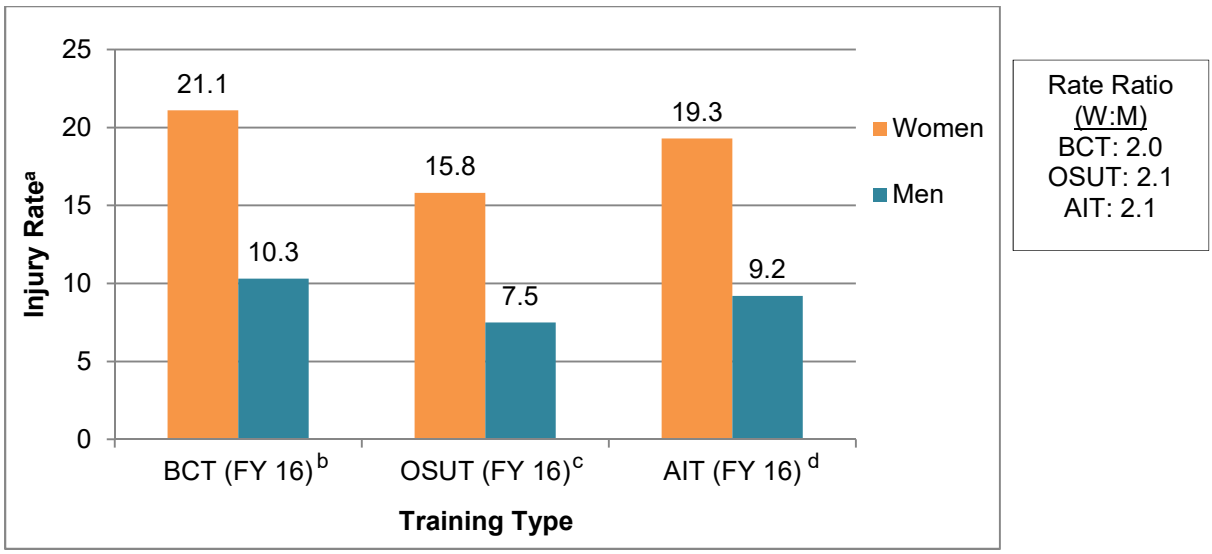
Table 10. Injury Rates by Gender and Component for AITs, FY 2016

	Component[a] Number Trained (n)		Component Injury Rate[b]		Component Rate Ratio by Gender
Gender	Active	National Guard (NG)	Active	National Guard (NG)	Active : NG
Women	275	117	20.1	12.6	1.6 (1.5 – 1.7)
Men	2,747	1,363	9.2	9.2	1.0 (1.0 – 1.0)

Notes:
[a] AITs include 13B, 13D, 13M, 13P, 13R, 91A, 91M, and 91P
[b] Rate = Number of injured Soldiers per 100 person-months of training
Sources: ATRRS and DMSS, prepared by APHC IPD

5.7 Summary of IET Injury Rates by Gender, FY 2016

Figure 10 summarizes the FY 2016 IET injury rates for both genders. In this figure, only the OSUTs and newly AITs that trained both genders in FY 2016 are included. The injury rate ratios (W:M) ranged from 2.0 to 2.1, indicating that injury rates for women were 2.0 to 2.1 times higher than rates for men. These IET rate ratios (W:M) are higher than the rate ratios (W:M) reported for the operational (i.e., post-IET) Active Army (rate ratio (W:M): 1.3)) (Figure 3). In other words, while women in IET have a two times higher injury rate compared to men, the injury rate for women in the Active Army is 1.3 times higher than for men.



Notes:
[a] Rate = Injured Soldiers per 100 person-months of training
[b] BCT includes Forts Jackson, Benning (men, only), Leonard Wood, and Sill (FY 2016)
[c] OSUTs that trained women and men: 12B, 12C,and 31B (FY 2016)
[d] AIT includes 13B, 13D,13M, 13P, 13R, 91A, 91M, and 91P

Figure 10. IET Injury Rates[a], FY 2016

6 CAUSES OF INJURY DURING INITIAL MILITARY TRAINING

6.1 Background and Methods

Identifying causes of injuries is an important step to target injury prevention strategies at leading causes of injury. In 2016, MSK injuries accounted for more outpatient visits for women (28% of total visits) and men (21% of total visits) in the Active Army than any other primary diagnosis group. But reporting the cause of injury (i.e., activity and mechanism) in the electronic health record is not mandatory for medical providers in outpatient clinics at the military treatment

facilities. As a consequence of the lack of a requirement to code causes of injury in the medical record, few injuries have a cause of injury listed or coded in the medical record.

To gain insights on the causes of injuries among accessions during their IMT, APHC IPD collaborated with ARI to incorporate a series of injury-related questions in surveys administered by ARI at the end of enlisted AIT courses and BOLCs. Soldiers reported the number of different MSK injuries they had during training. Those with a training injury were then asked what training activity they were doing when they had their most severe injury.

6.2 Results

The ARI administered surveys to 5,343 enlisted Soldiers (women: 831; men: 4,512) of whom 46 percent of women and 20 percent of men were injured during AIT between November 2016 and June 2017. During the same timeframe, 961 officers (women: 85; men: 876) were surveyed at the end of their BOLC, of whom 32 percent of women and 23 percent of men reported being injured.

Table 11 presents the leading activities associated with MSK injuries for enlisted women and men during AIT. Running, followed by marching or walking with a load, and physical training exercises (not running) were the most common activities associated with MSK injuries for enlisted women (42%, 25%, and 7%, respectively) and men (42%, 21%, and 8%, respectively).

Table 9. Leading Activities[a] Associated with MSK Injuries for Enlisted Women and Men in AIT (percent of all injuries)

Women		Men	
Activity[a]	**Percent (%)**	**Activity[a]**	**Percent (%)**
Running	42.4	Running	42.4
Marching/walking with a load	24.6	Marching/walking with a load	20.9
Physical training exercises (not running)	6.5	Physical training exercises (not running)	7.5
Obstacle or confidence course	4.2	Combatives	4.0
Climbing objects or steps	2.9	Obstacle or confidence course	3.8
Marching/walking with no load	2.6	Lifting or moving heavy objects (not weight training)	3.3
Combatives	2.1	Climbing objects or steps	2.6
Lifting or moving heavy objects (not weight training)	1.8	Marching/walking with no load	2.0

Note: [a] Activity associated with Soldier's self-reported most severe MSK injury

Table 12 displays the leading activities associated with MSK injuries for officer women and men during BOLC. Marching or walking with a load and running were the most common activities associated with injuries for officer women (37% and 22%, respectively) and men (35% and 21%, respectively). The third leading activity associated with MSK injuries was lifting or moving heavy objects (not related to weight training) for women (11%) and combatives for men (7%).

Table 12. Leading Activities[a] Associated with MSK Injuries for Officer Women and Men in IMT (percent of all injuries)

Women		Men	
Activity[a]	**Percent (%)**	**Activity[a]**	**Percent (%)**
Marching/walking with load	37.4	Marching/walking with load	35.0
Running	22.2	Running	21.0
Lifting or moving heavy objects (not weight training)	11.1	Combatives	7.0
Climbing objects or steps	3.7	Physical training exercises (not running)	6.5
Obstacle or confidence course	3.7	Sports	5.5
Rough-housing or fighting	3.7	Weight Training	5.5
Weight training	3.7	Obstacle or confidence course	4.5

Note: [a] Activity associated with Soldier's self-reported most severe MSK injury

6.3 Discussion/Conclusion

Causes of injury are needed to guide injury reduction and prevention planning and activities. Since causes of injury are currently not consistently coded in the electronic medical records data, surveys are often necessary to provide this information.

In this sample of women and men in AIT, weight-bearing activities, such as running and marching or walking with a load, accounted for 60 percent to 70 percent of injuries. Running, alone, accounted for just over 40 percent of injuries for both men and women in AIT. Modulation of the distances run and the amounts of road marching and loads carried by Soldiers is required to reduce injury rates in AIT.

Likewise for officers in BOLC, weight-bearing activities were the leading activities associated with injuries, accounting for 55 percent to 59 percent of all injuries. Among officer women and men, marching or walking with a load accounted for one-third of all injuries. As with Soldiers in AIT, the amount of marching (miles marched and weight of loads carried) and distances run in BOLC need to be considered in developing training schedules that will produce desired fitness levels if injuries are to be prevented.

See Appendix B for additional resources describing methods to reduce MSK injuries resulting from physical training activities such as marching and running.

7 OCCUPATIONAL PHYSICAL ASSESSMENT TEST ASSOCIATIONS WITH INJURY AND ATTRITION

7.1 Background

In 2013, the Department of Defense directed all military service branches to open all job assignments (or MOSs) to any capable Service member regardless of sex (HQDA, 2012). This directive established that the most important deciding factor in MOS assignment would be the ability to meet the physical demands associated with a given MOS, with equal standards for all Soldiers (U.S. Congress, 2016). Under the direction of TRADOC, USARIEM conducted the Physical Demands Study in which the physical demands of 32 military-relevant tasks were characterized (Foulis, 2017a; Foulis, 2017b). Once physical demands were established and tasks were narrowed to the most important required of Combat Arms MOSs (the most physically arduous MOSs), a follow-up study matched simple predictive field tests to Soldiers' ability to pass a High Physical Demands Test (HPDT) towards the end of IET (USARIEM, 2015b; Larcom, 2015). The combination of tests that was best able to predict Soldiers' ability to pass the HPDT was ultimately named the Occupational Physical Assessment Test (OPAT) (USARIEM, 2015a). The four-event OPAT measures physical attributes related to military task performance and consists of the seated power throw ((SPT); upper-body muscular power); standing long jump (SLJ; lower-body muscular power); strength deadlift (SDL; muscular strength), and the interval aerobic run (IAR; cardiorespiratory fitness) (Foulis, 2017b).

As of 3 January 2017, all men and women entering the U.S. Army are required to take the OPAT during the recruitment process prior to entering military service (HQDA, 2016a). Soldiers must achieve a minimum score on the four OPAT events, as established by TRADOC **(Table 13)** in order to qualify for enlistment into a given MOS. It is important to note that the lowest cut point from each of the four OPAT events determines the overall OPAT level achieved; therefore, if a Soldier achieved Gold in one event and Gray and Black in others, their overall OPAT would be considered Gold. The OPAT physical demand categories (PDCs) align with the determined physical demands for each MOS; each Soldier must meet the minimum sex-independent PDC (via OPAT testing) before entering a given MOS. For instance, an 88M (Motor Transport Operator) is a Black/Heavy MOS, while a 68W (Health Care Specialist) is Gray/Significant, and a 25D (Cyber Network Defender) is Gold/Moderate.

Table 13. OPAT Physical Demand Level and Associated Event Criteria

Physical Demand Level	Standing Long Jump (SLJ)	Seated Power Throw (SPT)	Strength Deadlift (SDL)	Interval Aerobic Run (IAR)
Black (Heavy)	160 cm 5'3"	450 cm 14'9"	160 lbs.	43 Shuttles (Stage 6-2)
Gray (Significant)	140 cm 4'7"	400 cm 13'1"	140 lbs.	40 Shuttles (Stage 5-8)
Gold (Moderate)	120 cm 3'11"	350 cm 11'6"	120 lbs.	36 Shuttles (Stage 5-4)
White (Not ready to ship)	Any event score below Gold (Moderate) level			

Note: Color (and Classification) assigned to Physical Demand Levels of each OPAT test event
cm: centimeter
lbs: pounds

7.2 Methods

The APHC IPD supported the TRADOC CIMT in the first longitudinal evaluation of the OPAT and its potential association with injury and attrition during BCT. The OPAT performance scores and medical encounter records were acquired for all Army Soldiers who began BCT on or after 3 January 2017 and trained in a BCT class scheduled to graduate by 9 June 2017. If Soldiers were still enrolled in a BCT class as of 9 June 2017, they were not included in this analysis. Raw OPAT data were provided by U.S. Army Recruiting Command, and performance scores were subsequently converted to color-level achievements established by TRADOC (**Table 13** above). The AFHSB provided the medical encounter data (i.e., outpatient clinic visits and hospitalizations) from the DMSS.

Injury was defined according to the Installation Injury Report (IIR) index developed by the AFHSB. Injuries identified by this index include primarily "acute/traumatic" and "overuse" injuries of the musculoskeletal system. Attrition was defined as any non-successful completion of the Soldier's first training cycle, such as being recycled for retraining, held-over, or discharged/separated from BCT for reasons which may have included injuries that existed prior to service [EPTS], entry level separation [ELS], behavior, and so forth. Both injury and attrition outcomes were considered only within the first training class to which Soldiers were assigned in BCT. To determine the relationships between injuries/attrition and performance on the OPAT, a chi-square analysis was conducted using IBM® Statistical Package for the Social Sciences (SPSS® version 21.0). Risk ratios were calculated using OpenEpi v. 3.01 (www.openepi.com).

7.3 Results

7.3.1 Overall OPAT Achievement

Using a single standard for men and women, the majority of male Soldiers achieved the highest PDC: Black/Heavy on the Overall OPAT test (64.7%), followed by Gray/Significant (20.0%), and Gold/Moderate (15.2%) **(Table 14)**. The most frequent achievement by female Soldiers was the second highest PDC: Gray/Significant (44.7%), followed by Gold/Moderate (33.8%), and

Black/Heavy (21.4%) **(Table 15)**. When combining all men and women using one OPAT standard, the most frequently achieved category tracked with the PDC groups in order from highest to lowest (Black: 54.8%, Gray: 25.7%, Gold: 19.4%; **Table 16**).

7.3.2 Injury Incidence by OPAT Achievement

Among BCT Soldiers, 31 percent of male Soldiers and 61 percent of female Soldiers were injured during the training cycle. When stratified by OPAT performance category, injury incidence increased with lower physical performance, such that classification into a PDC other than the Black/Heavy category increased the relative risk of injury in both men and women **(Tables 14 and 15)**. Twenty-nine percent of male Soldiers who met the Black OPAT standard were injured, compared to 34 percent and 35 percent in the Gray and Gold OPAT groups, respectively. This represented a 1.2 times higher ($p<0.01$) relative risk of injury for those who achieved the Gray and Gold overall OPAT levels, compared to those who achieved the Black overall level (Table 14). For female Soldiers, a similar pattern was observed. Among women who met the Black OPAT overall category, 58 percent were injured compared to 60 percent and 62 percent among those who met the Gray and Gold OPAT standards, respectively. The increased injury risk was only statistically significant for women who met the Gold overall standard: 1.1 times higher ($p=0.05$) injury risk than those who met the Black overall standard (Table 15).

Table 14. Injury Frequency and Injury Risk Ratios by OPAT Cut scores: BCT Men (n=13,067)

	Level Achieved	n	Injury (%)	Risk ratio (95% CI)	p-value
Overall OPAT Level	Black	8,457	29	1.00	
	Gray	2,619	34	**1.19 (1.12-1.27)**	**<0.01**
	Gold	1,984	35	**1.23 (1.15-1.31)**	**<0.01**
OPAT Color Interval Aerobic Run (# shuttles)	Black (≥43 shuttles)	9,157	29	1.00	
	Gray (40-42 shuttles)	2,157	35	**1.22 (1.15-1.31)**	**<0.01**
	Gold (36-39 shuttles)	1,747	36	**1.24 (1.15-1.33)**	**<0.01**
OPAT Color Seated Power Throw (cm)	Black (≥450 cm)	11,891	30	1.00	
	Gray (400-449 cm)	901	36	**1.18 (1.08-1.29)**	**<0.01**
	Gold (350-399 cm)	274	36	**1.20 (1.02-1.40)**	**0.04**
OPAT Color Standing Long Jump (cm)	Black (≥160 cm)	12,065	30	1.00	
	Gray (140-159 cm)	817	37	**1.21 (1.10-1.33)**	**<0.01**
	Gold (120-139 cm)	185	41	**1.34 (1.13-1.60)**	**<0.01**
OPAT Color Strength Deadlift (lbs.)	Black (≥160 lbs.)	12,091	30	1.00	
	Gray (140-159 lbs.)	569	37	**1.21 (1.08-1.35)**	**<0.01**
	Gold (120-139 lbs.)	407	33	1.08 (0.94-1.25)	0.27

Notes: Bolded values with corresponding p-value ≤ 0.05 indicate a significant injury risk ratio relative to individuals who scored in the Black OPAT category for the overall OPAT test or each separate event; 'n'

Notes: Table 14 (continued):
column represents the number of BCT Soldiers who achieved each level of overall OPAT or separate event; Risk ratios >1.0 indicate an increased relative risk, and risk ratios < 1.0 indicate a decreased relative risk.

Table 15. Injury Frequency and Injury Risk Ratios by OPAT Cut Scores: BCT Women (n=3,857)

	Level Achieved	n	Injury (%)	Risk ratio (95% CI)	p-value
Overall OPAT Level	Black	824	58	1.00	
	Gray	1,723	60	1.04 (0.97-1.12)	0.26
	Gold	1,305	62	**1.07 (1.00-1.15)**	**0.05**
OPAT Color Interval Aerobic Run (# shuttles)	Black (≥43 shuttles)	1,417	57	1.00	
	Gray (40-42 shuttles)	1,395	61	**1.07 (1.01-1.14)**	**0.02**
	Gold (36-39 shuttles)	1,042	63	**1.10 (1.04-1.18)**	**<0.01**
OPAT Color Seated Power Throw (cm)	Black (≥450 cm)	1,470	57	1.00	
	Gray (400-449 cm)	1,639	62	**1.08 (1.02-1.15)**	**0.01**
	Gold (350-399 cm)	747	63	**1.10 (1.03-1.19)**	**0.01**
OPAT Color Standing Long Jump (cm)	Black (≥160 cm)	2,064	57	1.00	
	Gray (140-159 cm)	1,404	64	**1.12 (1.06-1.18)**	**<0.01**
	Gold (120-139 cm)	389	65	**1.13 (1.04-1.23)**	**0.01**
OPAT Color Strength Deadlift (lbs.)	Black (≥160 lbs.)	2,582	59	1.00	
	Gray (140-159 lbs.)	889	63	**1.08 (1.01-1.14)**	**0.02**
	Gold (120-139 lbs.)	385	62	1.06 (0.97-1.15)	0.22

Notes: Bolded values with corresponding p-value ≤ 0.05 indicate a significant injury risk ratio relative to individuals who scored in the Black OPAT category for the overall OPAT test or each separate event; 'n' column represents the number of BCT Soldiers who achieved each level of overall OPAT or separate event; Risk ratios >1.0 indicate an increased relative risk, and risk ratios < 1.0 indicate a decreased relative risk.

When considering individual OPAT events, male Soldiers were injured more when they did not meet the Black/Heavy achievement standards on each of the four events. This resulted in a significantly elevated relative risk for injury in men that achieved the Gray or Gold standards on three of four events. In the SDL event, only the BCT Soldiers who met the Gray standard, had a significantly higher injury relative risk (1.21, P<0.01) compared to the Black/Heavy standard **(Table 14)**. In female Soldiers, injury incidence was higher for those who achieved the Gray or Gold standard for the individual events as well. Similar to men, the women who achieved the Gray standard in the SDL event (lifted between 140 and 159 lbs.) were at a significantly elevated injury relative risk (1.08, p=0.02) compared to those who achieved the Black/Heavy standard **(Table 15)**. When analyzing men and women together using one OPAT standard for the four individual events, meeting any performance standard lower than the Black/Heavy category resulted in more injuries and a significantly higher injury relative risk for each OPAT

event. In other words, Soldiers who achieved either Gray or Gold standards were between 1.33 and 1.68 times more likely to experience an injury compared to those with Black/Heavy standards for each OPAT event **(Table 16)**.

Table 16. Injury Frequency and Injury Risk Ratios by OPAT Cut Scores: BCT Men and Women Combined (n=16,924)

	Level Achieved	n	Injury (%)	Risk ratio (95% CI)	p-value
Overall OPAT Level	Black	9,281	32	1.00	
	Gray	4,342	44	**1.42 (1.36-1.48)**	**<0.01**
	Gold	3,289	46	**1.46 (1.40-1.54)**	**<0.01**
OPAT Color Interval Aerobic Run (# shuttles)	Black (≥43 shuttles)	10,574	33	1.00	
	Gray (40-42 shuttles)	3,552	45	**1.40 (1.33-1.46)**	**<0.01**
	Gold (36-39 shuttles)	2,789	46	**1.41 (1.34-1.48)**	**<0.01**
OPAT Color Seated Power Throw (cm)	Black (≥450 cm)	13,361	33	1.00	
	Gray (400-449 cm)	2,540	52	**1.58 (1.51-1.65)**	**<0.01**
	Gold (350-399 cm)	1,021	56	**1.68 (1.58-1.78)**	**<0.01**
OPAT Color Standing Long Jump (cm)	Black (≥160 cm)	14,129	34	1.00	
	Gray (140-159 cm)	2,221	54	**1.57 (1.51-1.65)**	**<0.01**
	Gold (120-139 cm)	574	57	**1.67 (1.55-1.80)**	**<0.01**
OPAT Color Strength Deadlift (lbs.)	Black (≥160 lbs.)	14,673	35	1.00	
	Gray (140-159 lbs.)	1,458	53	**1.50 (1.42-1.58)**	**<0.01**
	Gold (120-139 lbs.)	792	47	**1.33 (1.23-1.44)**	**<0.01**

Notes: Bolded values with corresponding p-value ≤ 0.05 indicate a significant injury risk ratio relative to individuals who scored in the Black OPAT category for the overall OPAT test or each separate event; 'n' column represents the number of BCT Soldiers who achieved each level of overall OPAT or separate event; Risk ratios >1.0 indicate an increased relative risk, and risk ratios < 1.0 indicate a decreased relative risk.

7.3.3 Attrition Incidence by OPAT Achievement

Attrition patterns for BCT Soldiers were different for men and women, such that female Soldiers attritted more than twice as frequently as male Soldiers (17.8% vs. 8.5% attrition, respectively) (data tables not shown). Interestingly, the attrition frequency was dependent on OPAT performance only among the male Soldiers. In this case, when compared to the Black/Heavy standards with 7 percent attrition, male Soldiers who met the lower Gray or Gold overall OPAT standard were 1.36 or 1.63 times more likely (both p<0.01) to attrit, respectively.

7.4 Discussion/Conclusion

Although there is one performance standard for a given MOS as per the OPAT, there are clear differences in injury incidence and attrition frequency between male and female Soldiers who recently entered BCT. For example, female Soldiers were injured and attritted from BCT about two times as often as male Soldiers. The current data further indicate that injury incidence and risk are clearly related to physical performance on the OPAT in BCT Soldiers. More specifically, male and female Soldiers who perform at a lower level than their cohorts (e.g., Gray/Significant or Gold/Moderate vs. Black/Heavy OPAT standards) are more likely to experience an injury during their BCT period. As noted above, however, attrition appears to be more dependent on OPAT performance in male Soldiers, as attrition was not dependent on overall OPAT performance in female Soldiers. Therefore, with multiple outcomes taken into consideration, for those who perform at a lower OPAT standard and/or enter MOSs with a lower PDC, modified training paradigms should also be considered. This could include training designed to improve fitness levels—in particular those fitness attributes highlighted by the OPAT—prior to attending BCT. Improving baseline fitness for entry-level Soldiers with sub-optimal physical fitness prior to BCT should theoretically reduce injury and attrition risk in this population.

8 MULTIVITAMIN WITH IRON: EVALUATION OF A PROGRAM FOR WOMEN IN INITIAL ENTRY TRAINING

8.1 Background

Maintaining sufficient iron levels is an important aspect of women's health, as women naturally lose iron during menstruation (Harvey, 2005; IOM, 2001). Iron deficiency (ID) and iron deficiency anemia (IDA) are prevalent conditions, with ID affecting approximately 16 percent of women in the U.S. population and IDA affecting up to 4 percent of women (IOM, 2001; McClung, 2016). One study showed similar prevalence of ID (13.4%) and IDA (5.8%) among women in Army IET, and even higher rates (32.8% ID and 20.9% IDA) in Army AIT (McClung, 2006). Another study confirmed that the likelihood of female Soldiers developing these deficiencies increases with additional training (McClung, 2009). Risk factors for ID and IDA among deployed Army Soldiers have been identified as female sex, regular menstruation, and a history of anemia (Wilson, 2011). Poor iron status can lead to decrements in physical endurance, aerobic adaptation, metabolism, and muscle fatigue (IOM, 2001; McClung, 2013).

To maintain iron stores in female Soldiers, Army Regulation 40-25 recommends a daily intake of 18 milligrams (mg) (compared to only 8 mg for men) (DA, 2017), which is consistent with the national recommendation for premenopausal women (IOM, 2001). Previous studies have investigated improving iron stores in female military members via supplement capsules (Booth, 2014; McClung, 2009) and iron-fortified food (Karl, 2010). These methods of supplementation improved both ID and mood. Similarly, when prenatal vitamins were given to female trainees in the Air Force, medical attrition was reduced by 26 percent (Barnes, 2015).

Considering these findings, MEDCOM and TRADOC collaborated to implement a new iron supplementation program. The MVI Working Group with representatives from TRADOC and subject matter experts from MEDCOM and USARIEM, developed, implemented, and provided

oversight of the MVI Program for Women in IET. The program makes available an MVI to all female trainees at BCT and OSUT installations (HQDA, 2016c). The working group requested that APHC conduct an evaluation of the effectiveness of the program 1 year after its implementation. The APHC's Public Health Review Board approved this program evaluation as public health practice.

8.2 Methods

For 1 year beginning in September 2015, BCT and OSUT female trainees at Forts Leonard Wood, Jackson, and Sill were offered an MVI with the intent of improving iron stores. Taking the supplement was entirely voluntary. Educational materials and medical support were also offered to female trainees as part of this effort. The MVI was not offered to male trainees.

Trainees were followed during their BCT or OSUT class for two outcomes: injuries and graduation status. Injury incidence (percent injured) and percent graduated among the units with women who were given MVIs (MVI groups) were compared to trainees in those units during the same time frame in the previous year (No-MVI groups). Training dates for those in the No-MVI and MVI groups are presented in **Table 17**. Outcomes among women were also compared to those for men who trained during the same time frames as the No-MVI and MVI groups of women, since men did not receive a supplement during either period. For BCT participants, results are presented by training installation. Results for BCT locations were also aggregated to provide overall BCT injury incidence.

Table 17. Training Period Dates for No-MVI and MVI Groups

Post	Training Type	No-MVI Groups	MVI Groups
Leonard Wood	BCT	1 Jan 15 – 31 Dec 15	1 Jan 16 – 31 Dec 16
Jackson	BCT	1 Apr 15 – 30 Mar 16	1 Apr 16 – 30 Mar 17
Sill	BCT	1 Jun 15 – 30 Mar 16	1 Jun 16 – 30 Mar 17

Results for selected OSUT classes were calculated but are not presented, given the lack of a robust female population among the baseline OSUT No-MVI groups.

Injuries were defined according to the AFHSB IIR index, which includes primarily acute/traumatic and overuse musculoskeletal injuries that occurred during each trainee's training dates. Cumulative injury incidence (percent of trainees with an injury during the specified period) is reported and relative risk (RR) comparing the risk of injury during the MVI period to injury risk during the No-MVI period was calculated.

Analysis of percent graduated in the two groups allows for evaluation of the potential effects of MVI use on graduation. Percent graduation is reported and RR was calculated, comparing the graduation during the MVI period to those during the No-MVI period.

All calculations of RR and 95 percent confidence intervals (95% CI) were calculated using OpenEpi (www.openepi.com). When injury and graduation outcomes for the MVI groups were compared to those among the No-MVI groups, differences with p-values ≤0.05 were considered statistically significant. Statistical differences in age and body mass index (BMI) (known risk factors for injury) were assessed between the No-MVI and MVI groups using a chi-square test for differences among categorical groups, and independent group t-tests for continuous variables; these calculations were conducted using the SAS software version 9.4.

8.3 Results

When comparing age and BMI between the No-MVI and MVI groups, significant differences (p<0.001) between the members of the two groups were observed for both men and women (data not shown). The average age was younger (1.6 years younger for women and 1.4 years younger for men), and the average BMI was slightly lower (0.1 lower for women and 0.4 lower for men) in the MVI groups, compared to the No-MVI groups.

As shown in **Table 18**, injury incidence among female trainees was statistically significantly lower in the MVI groups than in the groups that were not given MVIs at Forts Jackson and Leonard Wood. The risk of injury was 7 percent lower at both installations after the MVI implementation (MVI groups) compared to the No-MVI groups. Overall, among all BCT participants (including Fort Sill, which did not see a significant difference in injury incidence), female trainees after MVI implementation (MVI groups) had 3 percent lower risk of injury compared to those in the No-MVI groups.

Table 18. Female Injury Incidence, No-MVI and MVI Groups

	No-MVI Groups		MVI Groups			
Location	**Number Trained (n)**	**Percent Injured (%)**	**Number Trained (n)**	**Percent Injured (%)**	**RR (95% CI)**	**p-value**
Jackson	10,331	45.3	10,604	42.2	***0.93 (0.90, 0.96)***	***<0.001***
Leonard Wood	2,729	53.6	3,167	49.7	***0.93 (0.88, 0.97)***	***0.002***
Sill	4,262	33.7	3,354	35.5	1.05 (0.99, 1.12)	0.10
Overall	17,322	43.7	17,125	42.3	***0.97 (0.94, 0.99)***	***0.006***

Table 19 shows the results for male trainees who attended BCT during the same time frames as the No-MVI and MVI groups, though they did not receive an MVI at any time. The cumulative injury incidence during the observed training period among men in the MVI groups also significantly decreased at Fort Leonard Wood but increased at Fort Jackson and had no significant change at Fort Sill or overall.

Table 19. Male Injury Incidence, No-MVI and MVI Groups

	No-MVI Groups*		MVI Groups*			
Location	**Number Trained (n)**	**Percent Injured (%)**	**Number Trained (n)**	**Percent Injured (%)**	**RR (95% CI)**	**p-value**
Jackson	26,379	22.6	26,172	23.5	***1.04 (1.01, 1.08)***	***0.009***
Leonard Wood	8,291	26.8	8,778	23.8	***0.89 (0.84, 0.94)***	***<0.001***
Sill	10,501	14.4	9,466	15.2	1.05 (0.98, 1.13)	0.13
Overall	45,171	21.5	44,416	21.8	1.01 (0.99, 1.03)	0.21

Note: *It was not part of the program to give men MVIs; groups consist of integrated training classes during which female Soldiers were or were not offered MVIs.

Considering the effects of the MVI on graduation **(Table 20)**, no significant differences were observed overall for female trainees in BCT, though a significant increase was observed at Fort Leonard Wood and a significant decrease was observed at Fort Jackson. Among men, graduation significantly increased in all of BCT **(Table 21)**, with an increase at Fort Leonard Wood and a decrease at Fort Sill.

Table 20. Female Graduation (percent graduated), No-MVI Period and MVI Period

	No-MVI Groups		MVI Groups			
Training	**Number Trained (n)**	**Graduated (%)**	**Number Trained (n)**	**Graduated (%)**	**RR (95% CI)**	**p-value**
Jackson	10,331	83.1	10,604	81.8	***0.98 (0.97, 1.00)***	***0.02***
Leonard Wood	2,729	76.3	3,167	83.9	***1.10 (1.07, 1.13)***	***<0.001***
Sill	4,262	88.8	3,354	88.7	1.00 (0.98, 1.02)	0.91
Overall	17,322	83.4	17,125	83.6	1.00 (0.99, 1.01)	0.73

Table 21. Male Graduation (percent graduated), No-MVI Period and MVI Period

	No-MVI Groups*		MVI Groups*			
Training	**Number Trained (n)**	**Graduated (%)**	**Number Trained (n)**	**Graduated (%)**	**RR (95% CI)**	**p-value**
Jackson	26,379	90.6	26,172	90.8	1.00 (1.00, 1.01)	0.48
Leonard Wood	8,291	88.8	8,778	92.8	***1.05 (1.04, 1.06)***	***<0.001***
Sill	10,501	93.7	9,466	92.8	***0.99 (0.98, 1.00)***	***0.02***
Overall	45,171	91.0	44,416	91.6	***1.01 (1.00, 1.01)***	***<0.001***

Note Table 21:
*It was not part of the program to give men MVIs; groups consist of integrated training classes during which female Soldiers were or were not offered MVIs.

8.4 Discussion

8.4.1 Effects of MVI supplements on injuries

Because a statistically significant difference in overall injury incidence was observed among the groups of women who received MVI supplements, and a similar decrease was not observed overall among male trainees in the same time frame, it is possible that MVIs contributed to the decrease in injury incidence among women. While iron supplementation has not been previously shown to reduce injury incidence among female military personnel, it has been shown to decrease ID, which could lead to fewer injuries and improved performance (Booth, 2014; Karl, 2010; McClung, 2009).

However, there are limitations to note. First, MVI administration was voluntary, and there was no observation of whether the female trainees in the MVI groups actually took the MVI. Statistically significant differences were observed between the No-MVI and MVI groups for both age and BMI, known risk factors for injury (Jones, 2015). These variables may have also influenced injury incidence independent of MVI use.

8.4.2 Effects of MVI supplements on graduation

No conclusions can be drawn about the effects of MVI use on graduation. While some differences were observed for women in the No-MVI and MVI groups, even more significant differences were observed in the male comparison group. Therefore, it is likely that graduation was affected by factors unrelated to MVI intake.

8.5 Conclusions

Follow-up studies are recommended, as the current results do not provide conclusive evidence about the effects of MVIs for injury incidence or graduation among female trainees. A multivariate analysis controlling for factors such as training site, component, age, and body composition will be conducted to further evaluate the association of the MVI program with injury and graduation.

9 SUMMARY

This is the APHC IPD's and MEDCOM's second annual assessment of longitudinal studies and injury surveillance for the gender integration in the Army (HQDA, 2016b). Specifically, this assessment summarizes findings from: (1) injury surveillance of the operational (post-IET) Active Army and IET from 2011 to 2016, (2) causes of injury during IMT, (3) APHC's evaluation of the association of OPAT performance with injuries and graduation among BCT trainees (3 January to 9 June 2017), and (4) evaluation of a potential mitigation program to reduce the injury and attrition risks among women in IET.

Historically, injury rates for female Soldiers have been higher than rates for male Soldiers in the Active Army and IET. These injury rates provide important information about the overall injury risks for Soldiers and differences in injury rates between the genders. Overall, women in the Active Army have a 1.3 times higher injury rate compared to men **(Figure 4)**. Enlisted women have a 1.4 times higher injury rate than enlisted men, and female officers have a 1.2 times higher injury rate than male officers. More reliable comparisons of injury rates by gender will require large numbers of women and men of similar rank in the same MOS and with similar assignments.

During IET (i.e., BCT, OSUT, and AIT), large numbers of women and men perform the same training and are exposed to the same hazards and injury risks during training. For these reasons, IET provides a better comparison of injury rates for women and men than the operational Active Army where training and injury risks can vary depending on rank, MOS, assignment, and type of unit.

Women in IET (i.e., BCT, OSUT (12B Combat Engineer and 31B Military Police), and the eight AITs that opened to women since 2013) have a higher injury rate compared to men than do women in the Active Army. In FY 2016, injury rates for IET women were 2.0 to 2.1 times higher than rates for IET men (Figure 10). These 2 times higher injury rates for women have been reported consistently in BCT studies over the past 30 years. These 2 times higher injury rates for women may be closer to what we will see in the future for the women in the Active Army when we have larger numbers of women and men in the combat MOSs and AOCs and are able to differentiate injuries that occur on or off duty.

The APHC used self-reported survey data to identify the injury-related activities among Soldiers injured during AIT and BOLC. For AIT Soldiers, weight-bearing activities, such as running and marching or walking with a load, accounted for 60 percent to 70 percent of injuries. Running alone accounted for just over 40 percent of injuries for women and men. Among officers in BOLC, weight-bearing activities were also the leading activities associated with injuries, accounting for 55 percent to 59 percent of all injuries. Marching or walking with a load accounted for one-third of all injuries. Distances run and amount of marching (miles marched and weight of loads carried) must be considered in developing training schedules that will produce desired fitness levels if injuries are to be prevented.

Studies in IET and the operational Army have consistently shown that female and male Soldiers with lower levels of physical fitness have a higher injury risk compared to more physically fit Soldiers (Jones, 1993; Knapik, 2001). The higher injury rates for women and the relationship between lower physical fitness and increased injury risk for both genders emphasize the importance of matching physical fitness levels of new accessions with the heavy physical demands required for their MOS/AOC.

As of 3 January 2017, new accessions are required to pass the OPAT at the physical demand level assigned to their MOS/AOC (HQDA, 2016a). The OPAT ensures that Soldiers have the minimum level of physical fitness needed to perform the physically demanding tasks of their MOS/AOC. It is anticipated that the OPAT will have a secondary effect in reducing injuries and attrition. The APHC and TRADOC CIMT did a preliminary analysis of the OPAT among BCT

Soldiers that began training after 3 January 2017 and graduated by 9 June 2017. Male Soldiers with Gray and Gold overall OPAT scores had a 1.2 times higher injury risk (both $p<0.01$) than men with Black OPAT scores. Female Soldiers with Gray OPAT scores had a 1.1 times higher ($p<0.01$) injury risk compared to men who met the Black standard. Regarding attrition, men who met the lower Gray or Gold overall OPAT standard were 1.4 or 1.6 times more likely, respectively, to attrit during BCT.

The APHC conducted a program evaluation of the MVI Program for Women in IET. A significant decrease in overall injury incidence was observed among women who trained after the MVI program was implemented compared to women who trained before the program started. A similar decrease was not observed among men in the same timeframes. It is possible that MVIs contributed to the decrease in injury incidence among women. Follow-up studies are recommended, as the current results do not provide conclusive evidence about the effects of MVIs for injury incidence or graduation among female trainees.

10 GAPS IN DATA FOR INJURY SURVEILLANCE AND LONGITUDINAL STUDIES

The APHC IPD and MEDCOM have identified data gaps that may negatively affect the quality of outcome data for some injury surveillance and longitudinal studies for gender integration. These gaps are described below along with possible solutions. It is imperative that the APHC IPD and MEDCOM work through the HQDA G-1 Integrated Longitudinal Studies Work Group and the Soldier 2020 Injury Rates/Attrition Rates Work Group to describe these data shortfalls and coordinate efforts to ensure data systems are improved or developed that can provide these data.

10.1 Duty Status and Cause of Injury (Duty-related and MOS-related Injuries)

At present, injuries identified by the systematic injury surveillance include <u>all</u> injuries for which Soldiers seek medical care. We are unable to differentiate between injuries that occurred on duty versus off duty or that occurred while performing MOS-related duties versus other non-training activities. Causes of injury (i.e., activities and mechanisms) are not consistently coded in the medical records.

- **Possible Solutions:**
  - MEDCOM is working to increase entry of the available duty status and cause of injury codes in the current electronic health record and the new electronic health record being phased in over the next 5 years.
  - The revised eProfile system (updated Aug 2016) provides another schema for coding causes of injury and days of limited duty that may be more user-friendly for medical providers. MEDCOM will evaluate the data quality in eProfile in the first quarter of FY 2018.
  - Army surveys should include questions asking Soldiers about injuries sustained during training. Questions should ask if the injury occurred while on duty or off duty, what

was the cause/mechanism of the injury (e.g., fall, contact with an object or person, repetitive use, and so forth), and what activity was associated with the injury (e.g., running, weight lifting, other physical training, and so forth).

10.2 Duty Restrictions for Injuries

The number of days of limited duty and the extent of duty restrictions are important indicators of the severity and impact of injuries for longitudinal injury surveillance; however, these data were not currently accessible systematically for injury tracking and surveillance during the timeframe of this report.

- **Possible Solutions**

  - MEDCOM's eProfile is the enterprise system for entering and tracking injury-related duty restrictions; eProfile was recently upgraded in 2016 and should greatly increase access to these data for injury tracking and surveillance.

  - For the National Guard and Reserve, surveys are the best approach for estimating injury rates, injury-related duty limitations, causes of injury, and activity when the injury occurred. Surveys will also be valuable for the Active Army as a means of augmenting and validating injury causes and limited duty entered in eProfile by medical providers.

10.3 Access to APFT Performance Data

The physical fitness level of individual Soldiers is an important measure of readiness and physical performance and is a risk factor for injury. Access to APFT data through the enterprise data systems (i.e., DTMS) is required for planned longitudinal studies and surveillance.

Prior to 2016, RITMS was the system of record for training data in IET, including results of APFTs. However in 2016, RITMS was taken off-line and replaced with the DTMS. Since that transition, the training centers have not consistently entered APFT performance in DTMS.

In the Active Army, some units entered APFT data in DTMS, but compliance for entering these data in DTMS varies by unit and installation. The incompleteness of the APFT data in DTMS significantly limits any use of these essential data.

- **Possible Solution**

  - Greater command emphasis, additional administrative staff to assist with data input, and additional DTMS training are needed to increase use of DTMS by all three Army components.

10.4 Access to OPAT Performance Data for All Accessions

Electronic access to the OPAT test results for new accessions is required for the Longitudinal Validation of the OPAT Study, other longitudinal studies, and injury surveillance.

- **Possible Solution**

  - TRADOC is working to implement an enterprise system to archive and access OPAT test results.

10.5 Systematic Access to Electronic Medical Encounters and Duty/Drill/Training Dates for the National Guard and Reserve

Two factors significantly compromise MEDCOM's injury surveillance capability for the National Guard and Reserves: (1) lack of an enterprise system to systematically access electronic health records and (2) lack of reliable and complete data on training and drill dates.

- **Possible Solution**

  - MEDCOM anticipates this gap to be resolved with the 5-year systematic roll-out of the new electronic health record. In the meantime, unless other systematic sources of medical encounters and training data are identified, surveys will be the only means of obtaining injury rates, risk factors, causes of injury, and limited duty information for these components. For survey data to be valid and reliable, command support will be required to ensure adequate numbers of Soldiers respond to the surveys.

11 FUTURE PLAN FOR MEDCOM'S LONGITUDINAL STUDIES AND INJURY SURVEILLANCE

- The APHC IPD will expand the current injury surveillance for IET and the Army to monitor injury rates in—

  - OSUTs at Fort Benning (i.e., 11B/C, 19D, and 19K) that began training women during the second and third quarters of FY 2017,

  - Infantry and Armor BOLC, and

  - Cohorts of women and men in newly opened MOSs/AOCs from IET into their first unit of assignment.

- As co-investigator with USARIEM on the OPAT Longitudinal Validation Study, the APHC IPD will evaluate the association between OPAT study scores and injury incidence and APFT performance during IET and in the first 2 years of Soldiers' enlistments.

- The APHC IPD will continue to work with the TRADOC CIMT for the longitudinal evaluations of the OPAT. A full evaluation of CY 2017 accessions will be conducted in CY 2018 to further evaluate the associations of OPAT with injury, on-time graduation, and attrition in the first unit of assignment.

- The APHC IPD and MEDCOM are collaborating with ARI to conduct surveys to determine injury rates, causes, and risk factors. These unit and "end-of-training" assessments

(i.e., selected AITs and BOLCs) will provide important details about the causes of injury (i.e., activities and mechanism) and potential injury risk factors.

- Follow-up studies for the MVI Program for Women in IET are recommended. Multivariate analyses controlling for factors such as training site, component, age, and BMI will be conducted to further evaluate the association of the MVI program with injury and graduation.

- The APHC IPD and MEDCOM are supporting TRADOC in the development and evaluation of the Army Combat Readiness Test (ACRT). If approved and implemented, APHC will conduct longitudinal evaluations of the association of ACRT performance with injuries and other performance indicators.

- The APHC IPD and MEDCOM are also supporting U.S. Army Forces Command in the development and evaluation of the Soldier Readiness Test (SRT). If this test is implemented, APHC IPD will conduct longitudinal evaluations of the associations of SRT performance with injuries and other performance metrics.

12 POINT OF CONTACT

The point of contact for this report is Injury Prevention Division, email usarmy.apg.medcom-aphc.mbx.injuryprevention@mail.mil, or commercial phone 410-436-4655, or DSN 584-4655.

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APPENDIX A

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APPENDIX B

ARMY INJURY PREVENTION RESOURCES

Injury prevention fact sheets and training products are posted on APHC's Army Injury Prevention Web site: https://phc.amedd.army.mil/topics/discond/ptsaip/Pages/ArmyInjuryPreventionFactsheetsandTrainingProducts.aspx.

Links to related published papers can be found at the following APHC Injury Prevention Web site: https://phc.amedd.army.mil/topics/discond/ptsaip/Pages/References.aspx

Additional injury prevention strategies recommended by the Joint Services Physical Training Injury Prevention Working Group were as follows:

Recommended Injury Prevention Strategies (based on sufficient scientific evidence)

From: Bullock et al. Prevention of physical training-related injuries: Recommendations for the military and other active populations based on expedited systematic reviews. Am J Prev Med 2010;38(1S):S156–S181.

1. Prevent Overtraining *(strongly recommended)*

The Joint Services Physical Training Injury Prevention Working Group (JSPTIPWG) recommends a standardized physical training program that controls the amount of total body overload performed; particularly for the lower extremities. Lower extremity overtraining (caused largely by excessive distance running) results in higher injury rates, lowered physical performance, decreased motivation, and increased attrition. Good evidence was found that physical training programs, especially in initial military training that reduce distance running miles, prevent overtraining and reduce injury rates while maintaining or improving physical fitness. The elements described below should be incorporated to assist in reducing running mileage.

- Commanders at all levels should actively avoid combinations of physical and military training that exceed physiologic thresholds of training, as exceeding these thresholds result in higher injury rates with minimal or no improvement in fitness. Commanders can monitor profile (limited duty excusals) rates and fitness test pass rates and run times to determine if their units are overtraining. Signs that a unit is overtraining include high or increasing lower-body-injury profile rates, decreased fitness test pass rates, and slower average run times.

- Other ways to achieve this objective include the following recommendations:
  - Follow a gradual, systematic progression of running distance and speed beginning with lower mileage and intensity, especially for those just starting a physical training program (e.g., new trainees, changing units, or returning to physical training after time off for an injury or leave). This practice provides for less total running over a finite period of time.
  - Structure physical training injury prevention programs to target those Service members at the highest risk of injury (those of average or below average fitness) by ensuring that the running mileage for the least fit Service members is appropriate for their fitness level.
    a. Group Service members according to physical ability. For example, fitness test performance (run times) can be used to place Service members in groups of their

peers with similar fitness levels. This provides each Service member with a more appropriate level of physiological stimulus to enhance fitness and minimize injury risk.

b. Run for specified time periods, not distance. Running for specified time periods, not distance, allows the least fit to run shorter distances than the most fit, thus, accommodating low and high fitness groups simultaneously.

c. Limit running in formation. Placing limits on unit formation running allows a greater chance that Service members are provided an adequate training effect for maximum improvement through ability group running.

d. Avoid the practice of giving extra physical training sessions to the least fit Service members, especially trainees, since this will increase the risk of overtraining and injury with little or no fitness improvement. (Gradual, progressive ability group training programs improve fitness with less risk of overtraining and injury.)

e. Refrain from or modify use of physical training as a punitive, corrective, or motivational tool as it has the potential to cause excessive training overload that can lead to overtraining. Other methods to discipline trainees should be sought, or the amount and type of physical demands placed on a trainees should be limited and standardized (e.g., a maximum number of push-ups allowed per day). An activity that we want Service members to embody for a career and a lifetime should not be used for punishment.

- Replace some distance runs with interval running (multiple bouts of short distance, high intensity running interspersed with periods of recovery) that increase speed and stamina more rapidly than distance running while limiting total running miles.

- Balance the body's need for a physiologic training overload to improve fitness with the need for recovery and rebuilding by coordinating military and physical training to—

a. Avoid exhaustive military or physical training (e.g., obstacle courses, long road marches with heavy loads, longer runs, maximal-effort physical fitness testing, and so forth) on the same or successive days.

b. Allow adequate recovery time between administrations of maximal effort physical fitness tests to prevent overtraining and increase the likelihood of improved physical performance. (Since muscle soreness peaks at 48 hours the minimum recovery time would be 3–5 days).

c. Alternate training days that emphasize lower body weight-bearing physical activity with training days focused on upper body conditioning.

d. Minimize the accumulated weight-bearing stress on the lower body from marching/hiking, movements to training sites, drill and ceremony, obstacle courses, running, and so forth, by not over scheduling such activities on the same or successive days.

2. Perform Multiaxial, Neuromuscular, Proprioceptive, and Agility Training *(Recommended)*

The JSPTIPWG recommends that multiaxial (many plains of motion), neuromuscular (coordinated muscular movement), proprioceptive (body position sense), and agility (non-linear movement) exercises be included as a regular component of military physical training programs. The work group found good evidence that injuries are reduced by increasing the proportion of physical training time devoted to exercises that vary musculoskeletal stress in multiple plains and improve body coordination, position sense, and agility.

3. Wear Mouthguards during High-Risk Activities *(Recommended)*

The JSPTIPWG recommends all Services provide mouthguards for all Service members participating in activities with a high risk for orofacial injuries. The work group found good evidence that mouthguards reduce orofacial injuries when worn during activities with high orofacial injury risk. Examples of potential high-risk activities listed by the work group include combatives, obstacle and confidence courses, rifle/bayonet training, and so forth, and contact sports such as basketball, football, and so forth. The evidence is insufficient to recommend for or against mouthguards as a means of preventing concussion injuries.

4. Wear Semi-rigid Ankle Braces for High Risk Activities *(Recommended)*

The JSPTIPWG strongly recommends that semi-rigid ankle braces be utilized during participation in high-risk physical activity. The work group found good evidence that semi-rigid ankle braces reduce ankle injuries when participating in high-risk physical activity such as airborne operations (parachuting), basketball, and soccer and may prevent ankle injuries in other similar high risk activities. Additionally, the work group found good evidence that semi-rigid ankle braces reduce re-injury among individuals with previous moderate or severe ankle sprains.

5. Consume Nutrients to Restore Energy Balance within 1 Hour Following High-Intensity Activity *(Recommended)*

The JSPTIPWG recommends consuming 12–18 grams of protein and 50–75 grams of carbohydrate and a fluid replacement beverage within 1 hour after very strenuous, continuous physical activity (e.g., road marching/hiking lasting longer than 1 hour) to minimize muscle damage and optimize recovery. The work group found sufficient evidence that consuming this balance of nutrients within a 1-hour time frame restores energy balance and optimizes recovery from musculoskeletal breakdown caused by the activity. Collateral benefits, such as reduced risk of heat-related illness and enhanced physical performance, can be expected.

6. Wear Synthetic Blend Socks to Prevent Blisters *(Recommended)*

The JSPTIPWG recommends the use of synthetic blend socks (e.g., polyester, acrylic, and nylon versus cotton socks) to prevent blisters to the feet during physical training. The work group found at least fair evidence that synthetic-blend socks prevent blisters to the feet, especially during long-distance marching.

Glossary

Abbreviations

ACRT	Army Combat Readiness Test
AOC	area of concentration
AIT	Advanced Individual Training
APFT	Army Physical Fitness Test
AFHSB	Armed Forces Health Surveillance Branch, Defense Health Agency
APHC	Army Public Health Center
ARI	Army Research Institute for the Behavioral and Social Sciences
ATRRS	Army Training Requirements and Resources System
Auto	Automated
BCT	Basic Combat Training
BMI	body mass index
BOLC	Basic Officer Leadership Course
cm	centimeter
CI	confidence interval
CIMT	Center for Initial Military Training
CY	calendar year
DTMS	Digital Training Management System
DMSS	Defense Medical Surveillance System
ELS	entry level separation
EPTS	existed prior to service
EXORD	Execution Order

FY	fiscal year
HPDT	High Physical Demands Test
HRC	U.S. Army Human Resources Command
HQDA	Headquarters, Department of the Army
IAR	interval aerobic run (OPAT)
ID	iron deficiency
IDA	iron deficiency anemia
IET	Initial Entry Training
IIR	Installation Injury Report
IMT	Initial Military Training
IOM	Institute of Medicine
IPD	Injury Prevention Division, Army Public Health Center
lbs	pounds
M	men
MEDCOM	U.S. Army Medical Command
mg	milligram
MLRS	Multiple Launch Rocket System
MOS	military occupational specialty
MSK	musculoskeletal
MVI	multivitamin with iron
NG	National Guard
OPAT	Occupational Physical Assessment Test
OSUT	One Station Unit Training

PDC	Physical Demand Categories
RITMS	Resident Individual Training Management System
RR	relative risk
SDL	strength deadlift (OPAT)
SLJ	standing long jump (OPAT)
SPT	seated power throw (OPAT)
SECDEF	Secretary of Defense
Spec	Specialist
SPSS	Statistical Package for the Social Sciences software
SRT	Soldier Readiness Test
TRADOC	U.S. Army Training and Doctrine Command
USARIEM	U.S. Army Research Institute of Environmental Medicine
W	women

Definitions

Cohort: a group of people banded together or treated as a group.

Injury Rate (operational Army): number of injuries per 1,000 person-years of training. or example, an injury rate of 1,500 per 1,000 person-years means there were 1,500 injuries among 1,000 Soldiers who each trained for 1 year.

Injury Rate (IET): number of injured Soldiers per 100 person-months of training. For example, an injury rate of 10 per 100 person-months means that 10 Soldiers had at least one injury during 100 person-months of training. In BCT (10-weeks in duration), 100 person-months are equivalent to 40 Soldiers who each trained for 10 weeks (2.5 months).

Injury Rate Ratio (Women:Men)**:** calculated by dividing the injury rate for women (W) by the injury rate for men (M). Example: a rate ratio (W:M) equal to 1.5 indicates that the injury rate for women was 1.5 times higher than the rate for men.

Overuse Injuries: musculoskeletal injury that occurs gradually over time in response to low intensity, repetitive mechanical forces (e.g., Achilles tendonitis, “runner’s knee” and stress fractures).

Traumatic Injuries: musculoskeletal injury that occurs after a sudden application of mechanical force or energy such as occurs when falling to the ground or being struck by an object or person.

Military Occupational Specialties (MOS):

Armor (19 series)
- 19D Cavalry scout
- 19K M1 Armor crewmember

Engineer (12 series)
- 12B Combat engineer
- 12C Bridge crewmember

Field Artillery (13 series)
- 13B Cannon Crewmember
- 13D Field Artillery Automated Tactical Data System Specialist
- 13M Multiple Launch Rocket System Crewmember
- 13P Multiple Launch Rocket System operations/fire detection specialist
- 13R Field Artillery Firefinder Radar Operator

Field Mechanical Maintenance (91 series)
- 91A M1 Abrams tank system maintainer
- 91M Bradley Fighting Vehicle System Maintainer
- 91P Artillery Mechanic

Infantry (11 series)
- 11B Infantryman
- 11C Indirect Fire Infantryman

Military Police (31 series)

Special Forces (18 series)