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Keith G. Hauret (1), Ryan A. Steelman (1), Joseph R. Pierce (1), Joseph A. Alemany (1), Marilyn A. Sharp (2), Stephen A. Foulis (2), Jan E. Redmond (2), Maria C. Canino (2), Bruce S. Cohen (2), Michael S. McGurk (3), Whitfield B. East (3), Bruce H. Jones (1)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
(1) Injury Prevention Division, U.S. Army Public Health Center, Aberdeen Proving Ground, MD; (2) Military Performance Division, U.S. Army Research Institute of Environmental Medicine, Natick, MA; (3) U.S Army Center for Initial Military Training, Fort Eustis, VA

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14. ABSTRACT

The Occupational Physical Assessment Test (OPAT) was developed as a pre-enlistment test to match the right Soldier with the right job(s) (e.g., military occupational specialties (MOSs)) based on sex-neutral physical performance standards. The 4-event OPAT measures physical attributes required to perform the physically demanding tasks of the Combat Arms MOSs. This study was designed to prospectively evaluate potential relationships between physical performance on the 4-event OPAT and two important outcome measures (i.e., injury and attrition) during IET. Among sexes combined and men alone, achievement on the composite (4-event) OPAT was inversely associated with injury risk during the first 10 weeks of IET. Trainees in the Gray (combined sexes: $p=0.02$; men: $p=0.02$) and White categories (combined sexes: $p<0.01$; men: $p<0.01$) had significantly higher injury risk compared to trainees that met the OPAT standard for the Black PDC. Among sexes combined and men, achievement on the composite OPAT was inversely associated with final IET attrition. Trainees in the lowest performing White category had significantly higher final attrition compared to trainees that met the standard for the Black PDC (sexes combined: $p<0.001$; men: $p<0.01$).

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Occupational Physical Performance Test (OPAT), Initial Entry Training (IET), injuries, attrition, physical fitness

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Contributing Authors

Keith G. Hauret, MSPH, MPT[1]

Ryan A. Steelman, MPH[1]

Joseph R. Pierce, Ph.D.[1]

Joseph A. Alemany, M.S.[1]

Marilyn A. Sharp, M.S.[2]

Stephen A. Foulis, Ph.D.[2]

Jan E. Redmond, Ph.D.[2]

Maria C. Canino, M.S.[2]

Bruce S. Cohen, Ph.D.[2]

Michael S. McGurk, MS[3]

Whitfield B. East, EdD[3]

Bruce H. Jones, MD, MPH[1]

[1] Injury Prevention Division, Clinical Public Health and Epidemiology Directorate, U.S. Army Public Health Center, Aberdeen Proving Ground, Maryland

[2] Military Performance Division, U.S. Army Research Institute of Environmental Medicine, Natick, Massachusetts

[3] U.S. Army Center for Initial Military Training, Fort Eustis, Virginia

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EXECUTIVE SUMMARY
Public Health Report No. S.0047229-18b
Association of Performance on the Occupational Physical Assessment Test, Injuries, and Attrition during Initial Entry Training: OPAT Phase I

1 Purpose

The Occupational Physical Assessment Test (OPAT) was developed as a pre-enlistment test to match the right Soldier with the right job(s) (e.g., military occupational specialties (MOSs)) based on sex-neutral physical performance standards (USARIEM 2018). The 4-event OPAT measures physical attributes required to perform the physically demanding tasks of the Combat Arms MOSs. It will also serve as a pre-accession physical fitness test to ensure new accessions meet minimum standards of fitness. The four OPAT events and fitness components (i.e., physical attributes) they measure are—

- Seated Power Throw (SPT: upper-body muscular power) (Foulis et al. 2017, USARIEM 2018),
- Standing Long Jump (SLJ: lower-body muscular power) (Foulis et al. 2017, USARIEM 2018),
- Strength Deadlift (SDL; muscular strength) (Foulis et al. 2017, USARIEM 2018), and
- Interval Aerobic Run (IAR; cardiorespiratory fitness) (Canino et al. 2018, Leger et al. 1988)

Studies in Initial Entry Training (IET) show that injury and attrition risks are highest among low-fit trainees. They have consistently found that higher injury risk is associated with lower aerobic fitness and to a lesser degree with upper- and lower-body muscular endurance (Bedno et al. 2013, Jones and Hauschild 2015, Knapik, Sharp et al. 2001). Studies have confirmed that low levels of physical fitness at accession and injuries sustained during IET are factors that increase the likelihood for discharge from the Army (i.e., attrition) during IET (USACHPPM 2004a, Knapik, Canham-Chervak, Hauret et al. 2001, Niebuhr et al. 2008).

The OPAT Longitudinal Validation Study was designed to validate the 4-event OPAT among entry-level Soldiers (i.e., trainees) (USARIEM 2018). Secondarily, it was designed to prospectively evaluate potential relationships between physical performance on the 4-event OPAT and two important outcome measures (i.e., injury and attrition) during IET. The U.S. Army Research Institute of Environmental Medicine (USARIEM), the U.S. Army Training and Doctrine Command (TRADOC), and the U.S. Army Public Health Center (APHC) collaborated on the study, which was conducted in 2016 before the U.S. Army implemented the OPAT in January 2017.

The USARIEM Institutional Review Board approved the OPAT Longitudinal Validation Study. From January to December 2016, researchers collected OPAT physical performance data,

medical encounters for injuries, and IET attrition status (i.e., discharge versus graduation) for trainees enrolled in the study at three Army IET installations (Fort Benning, Georgia; Fort Leonard Wood, Missouri; and Fort Sill, Oklahoma).

The purpose of this report is to describe the relationships between OPAT performance within the first two weeks of IET and prospective outcomes for injury and attrition during IET. The report is part of a series of related reports by USARIEM and APHC on the OPAT Longitudinal Validation Study.

2 Findings

This is the first report to document the associations between physical performance on the OPAT with injuries from medical records and attrition during IET. Trainee performance on the OPAT was categorized into four categories established by TRADOC (i.e., 3 physical demand categories (PDCs: Black, Gray, and Gold) and a fourth category (White) for trainees who did not meet the PDC performance standards). Findings from this study demonstrate that—

- Among sexes combined and men alone, achievement on the composite (4-event) OPAT was inversely associated with injury risk during the first 10 weeks of IET. Trainees in the Gray (combined sexes: $p=0.02$; men: $p=0.02$) and White categories (combined sexes: $p<0.01$; men: $p<0.01$) had significantly higher injury risk compared to trainees that met the OPAT standard for the Black PDC.

- Among sexes combined, there were significant inverse trends for injury on the SLJ and SDL events such that injury risks increased as event performance decreased going from the Black PDC to the White category (SLJ: $p<0.001$; SDL: $p<0.001$). Among men and women, separately, only the IAR event was associated with injury risk. Among men, injury risk was significantly higher for trainees in the IAR Gray PDC ($p=0.02$) and White category ($p<0.01$) compared to men in the Black PDC. Among women, injury risk was significantly higher for women in the IAR White category ($p=0.02$) compared to women in the Black PDC.

- Among sexes combined and men alone, achievement on the composite OPAT was inversely associated with final IET attrition. Trainees in the lowest performing White category had significantly higher final attrition compared to trainees that met the standard for the Black PDC (sexes combined: $p<0.001$; men: $p<0.01$).

- Among sexes combined, there were significant inverse trends for attrition on the SDL ($p<0.001$) and IAR ($p<0.001$) events such that final attrition risk increased as event performance decreased going from the event's Black PDC to the White category. Among men and women separately, men in the White category on the IAR event ($p<0.01$), and women in the White category for the SPT ($p<0.01$) and IAR ($p=0.04$) events had significantly higher attrition compared to trainees in the respective Black PDC within sex.

- Similar to previous findings of significant relationships between decreased aerobic fitness (e.g., increased 2-mile run time) and increased injury risk (Lisman et al. 2017, Jones,

Bovee et al. 1993, Knapik, Sharp et al. 2001), we observed that lower number of IAR shuttles (indicator of lower aerobic fitness) on the OPAT was also associated with elevated injury risk among men and women, separately and combined.

- Field-expedient muscular strength and power tests offered by the OPAT provided new insight into the relationship of these fitness components with injury and attrition risk among trainees.

3 Recommendations and Next Steps

Based on the above findings, we recommend that the OPAT be fully operationalized to not only match Soldiers to the right job based on physical ability, but also as a pre-accession fitness assessment. This will ensure that recruits entering the Army meet minimum physical fitness standards with likely resultant lower injury and attrition rates in IET.

In the future, public health agencies conducting surveillance (e.g., APHC) and researchers (e.g., USARIEM) will need routine access to digital OPAT performance data for all accessions and Soldiers that are required to take the OPAT to reclassify their MOS. As with Army Physical Fitness Test performance data in the Army Training Management System (ATMS), the accessible OPAT data must include all iterations of the OPAT during each Soldier's time in Service (i.e., should not be limited to only the most recent iteration of the OPAT).

Future surveillance and research should be conducted to—

- Routinely monitor physical fitness levels among trainees;
- Track injury incidence and attrition during IET and in the first unit of assignment;
- Re-evaluate the associations of OPAT, injuries, and attrition; and
- Continue to study relationships between components of physical fitness, injuries, and attrition in IET and the operational Army.

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1 REFERENCES

See Appendix A for a list of references used in this report.

2 AUTHORITY

The Injury Prevention Division, U.S. Army Public Health Center (APHC), is responsible under Army Regulation (AR) 40-5, Section 2-19, to provide support to the U.S. Army Medical Command (MEDCOM) for comprehensive medical surveillance to identify, prevent, and control evolving health problems (DA 2007). The APHC and MEDCOM are responsible for support to Headquarters, Department of the Army (HQDA) G-1 and the U.S. Army Training and Doctrine Command (TRADOC) in the implementation and longitudinal validation of the Occupational Physical Assessment Test (OPAT) (DA 2016b).

3 INTRODUCTION

3.1 Purpose

This report represents a subset of data from the OPAT Longitudinal Validation that was conducted in 2016 at three of the Army's Initial Entry Training (IET) centers. The purpose of this report is to describe the relationships between performance on the composite (4-event) OPAT administered at the beginning of IET, incident injuries, and attrition during the course of training.

3.2 Scope

In addition to applying the public health process to achieve its mission, the APHC collaborates with other MEDCOM entities on injury surveillance, development and evaluation of programs, and research that aim to optimize Soldier health and readiness throughout the Soldiers' life cycle. The U.S. Army Research Institute of Environmental Medicine (USARIEM), U.S. Army Training and Doctrine Command (TRADOC), and the APHC collaborated on the OPAT Longitudinal Validation Study. From January to December 2016, data were collected on OPAT performance, medical encounters for injuries, and IET attrition status (discharged or recycled for training versus successful completion) for subjects enrolled in the study at three Army IET installations (Fort Benning, Georgia; Fort Leonard Wood, Missouri, and Fort Sill, Oklahoma). This study was conducted prior to the Army's implementation of the OPAT in January 2017 as a pre-enlistment tool to match recruits' physical capability to the physical demands of the military occupational specialties (MOSs) (DA 2016a).

This report describes the relationships between OPAT performance at the start of IET and prospective outcomes for injury and attrition during IET. The report is part of a series of related reports by USARIEM and APHC on the OPAT Longitudinal Validation Study.

3.3 Background

On 24 January 2013, the Secretary of Defense (SecDef) rescinded the 1994 Direct Ground Combat Definition and Assignment Rule and directed the integration of women into the combat occupational fields that were previously restricted to women (Secretary of Defense 2013). To ensure all Service members would be physically capable of performing tasks required of their occupational specialty, the SecDef directed the Military Services to develop and implement validated, sex-neutral occupational standards.

In April 2013, HQDA issued a directive of required Army actions to support integration of women into the Combat Arms MOSs (DA 2013). It assigned TRADOC with responsibility for developing sex-neutral physical standards for the seven Combat Arms MOS (i.e., 11B infantryman, 11C Infantryman-indirect fire, 12B Combat Engineer, 13B Cannon Crewmember, 13F Fire Support Specialist, 19D Cavalry Scout, and 19K Armor Crewmember).

Going forward, in addition to a recruit's cognitive ability, the ability to meet MOS-specific physical demands based on a sex-neutral physical standard will be used in assigning the recruit (or reclassifying Soldier) to a Combat Arms MOS. USARIEM conducted the Physical Demands Study to quantify the physical demands of 32 military-relevant tasks performed by one or more of the Combat Arms MOSs (Foulis et al. 2017). From the investigation, USARIEM selected the most physically demanding tasks; a follow-up study matched simple predictive physical tests to Soldiers' ability to perform these tasks to standard (i.e., Criterion Measure Task Simulations (CMTS)). TRADOC selected the test battery that predicted ability to perform the CMTS and did not require calibrated test equipment. This test battery, known as the OPAT, has four events: Seated Power Throw (SPT), Standing Long Jump (SLJ), Strength Deadlift (SDL), and Interval Aerobic Run (IAR) (Foulis et al. 2015, Foulis et al. 2017, USARIEM 2018). The SPT and SLJ events were assessments of upper- and lower-body muscular power; the SDL event was an assessment of muscular strength and the IAR event was an assessment of aerobic fitness (Canino et al. 2018, Foulis et al. 2015, Leger et al. 1988, USARIEM 2018).

The OPAT Longitudinal Validation Study was designed to validate the 4-event OPAT among trainees since the test battery was developed using performance data from Active Duty Soldiers (USARIEM 2018). Using a subset of data from that study, the current investigation was designed to prospectively evaluate potential relationships between performance on the composite (4-event) OPAT and two important IET outcome measures (i.e., injury and attrition) that were previously found to be associated with lower levels of entry-level aerobic fitness as measured by the 2-mile run event on the Army Physical Fitness Test (APFT) (Bedno et al. 2013, Knapik, Canham-Chervak, Hauret et al. 2001, Knapik, Sharp et al. 2001, Niebuhr et al. 2008, USACHPPM 2004a).

Injury rates during Basic Combat Training (BCT) and One Station Unit Training (OSUT) are historically higher than rates for the operational (post-IET) Army (Jones et al. 2017). Injury incidence in Army BCT (percent of trainees injured per cycle) has been monitored for more than 30 years and has ranged from 14 to 31% for men and from 36 to 67% for women (USAPHC

(Prov) 2008, APHC 2017). During Infantry OSUT (approximately 13 weeks duration), injury incidence among the men has ranged from 29.9 to 45.9% cycle (APHC 2017, Jones, Bovee et al. 1993, Jones, Cowan et al. 1993).

The relationship between entry-level physical fitness and injuries during IET has been evaluated in each of the Military Services (Jones, Cowan et al. 1993, Knapik, Sharp et al. 2001, USAPHC (Prov) 2008). Higher injury risk has consistently been associated with lower aerobic fitness. Individuals with low aerobic capacity may experience greater physiologic stresses on body systems from working at a higher percentage of their aerobic capacity during strenuous training events (Almeida et al. 1999, Jones, Bovee et al. 1993, Knapik, Sharp et al. 2001, Snoddy and Henderson 1994). Upper- and lower-body muscular endurance (measured with push-ups, pull-ups, or the flexed arm hang) and lower abdominal muscle endurance (measured with sit-ups or crunches) have also been associated with increased injury risk (Jones, Bovee et al. 1993, Knapik, Sharp et al. 2001). However, the relationships between injury risk and muscular endurance are not as consistent or strong as those observed between injury risk and aerobic fitness.

Attrition in IET (i.e., discharges) is another important outcome with far-reaching impacts on training and readiness. From Fiscal Year (FY) 2015 to FY 2017, the 12-month IET attrition incidence for the Army ranged from 9.6 to 11.6% of accessions (Center for Initial Military Training 2018). From 2010 to 2015, 12.3% of Active component accessions attritted by the end of their first year in service (including IET) (Accession Medical Standards Analysis & Research Activity 2017). This attrition directly affects the costs for recruiting and training. In FY 2016, the average cost to recruit, in-process, and train Army recruits attending BCT followed by Advanced Individual Training (AIT) was $68.1K; the cost was $50.6K for OSUT (Training Requirements Office 2016). Attrition in IET also negatively impacts readiness of the operational units that are programmed to receive these trainees when they complete their IET.

Studies have provided substantial evidence for the association of low levels of physical fitness at accession and injuries during BCT with increased likelihood for attrition from IET (Knapik, Canham-Chervak, Hauret et al. 2001, USACHPPM 2004a). During BCT, men and women with an injury were 3.3 and 1.2 times more likely, respectively, to be discharged compared to uninjured trainees of the same sex (Knapik, Canham-Chervak, Hauret et al. 2001, USACHPPM 2004a). A study of Infantry OSUT (13 weeks) found that the trainees' entry-level physical fitness, as assessed by the 3-event APFT (2-minute push-up test, 2-minute sit-up test, and 2-mile run for time) at the beginning of OSUT, was among the most consistent predictors of training success versus discharge (Snoddy and Henderson 1994). Low performance on any one of the three APFT events was correlated with discharge. Based on these findings, the author recommended that the Army administer a fitness test to all prospective recruits and establish standards for selection. More recent studies that investigated the relationship between accession physical fitness and attrition have similarly recommended a pre-accession fitness test as a means to reduce IET attrition (Loughran and Orvis 2011, Niebuhr et al. 2008).

As previously described, the OPAT is a 4-event physical performance assessment designed to screen Army recruits for meeting the physical demands of their MOS. Prior to the

institutionalization of the OPAT for all Army MOSs, the OPAT Longitudinal Validation Study was conducted to validate the OPAT in Army trainees during IET since the test battery was developed using performance data from Active Duty Soldiers. Given the relationships between physical fitness, injury, and attrition, OPAT performance as an accession-level measure of physical fitness may be associated with injury and attrition during IET. The purpose of this current study was to evaluate prospectively the association of OPAT performance at the beginning of IET with incident injuries and attrition during IET, and to provide leadership with insight into these relationships.

4 METHODS

4.1 Study Overview

In January 2016, USARIEM began enrolling trainee volunteers in the OPAT Longitudinal Validation Study, which was approved by the USARIEM Institutional Review Board (Protocol #16-04). The APHC collaborated to assist with data collection and perform the injury- and attrition-related portion of the analysis. Subjects provided their verbal and written informed consent in front of an ombudsman following a briefing on study procedures, benefits, and risks. The investigators adhered to the protocol and policies for protection of human subjects prescribed in AR 70-25 (DA 1990); the research was conducted in adherence with provisions of Title 32 Code of Federal Regulation (CFR), Part 219 (NARA 2017). In compliance with Department of Defense Instruction (DoDI) 3216.202 (DOD 2011), trainees who were 17 years of age were considered adults while in Federal-duty status and were allowed to consent without parent or guardian approval. During the timeframe of this study, the Army had not yet implemented the OPAT as a pre-enlistment standard.

4.2 Volunteer Enrollment and Follow-up

A total of 1,181 trainees (n=948 men, n=233 women) were enrolled in the OPAT Longitudinal Validation Study at one of three IET installations (Fort Benning, Georgia; Fort Leonard Wood, Missouri; Fort Sill, Oklahoma). The study cohort consisted of U.S. Army trainees that began IET between January and August 2016. During their Army recruitment, they had a medical qualification examination as required to enlist in the Army (i.e., AR 40-501, *Standards of Medical Fitness* (DA 2017). Study participants (trainees) attended an information and informed-consent briefing within 2 weeks of arrival for training. They were informed of all study procedures, potential risks, and benefits associated with participating in the study. They completed a medical screening questionnaire; trainees were deemed ineligible to participate if they were on physical profile with duty restrictions/limitations for any medical condition, were pregnant, or were unable to perform exercises or physically demanding tasks. Following the briefing, volunteers provided verbal and written informed consent in front of an ombudsman.

Enrolled trainees scheduled to attend BCT were followed during BCT and through their AIT at the same installation. The OSUT trainees were followed through the completion of their training. Male volunteers were from the following Combat Arms MOSs: 11B (Infantry), 11C (Infantry, Indirect Fire) 12B (Combat Engineer), 13B (Cannon Crewmember), 13F (Fire Support

Specialist), 19D (Cavalry Scout), and 19K (Armor). Female volunteers were recruited from the 12B, 13B and 13F MOSs. Since women were not yet being recruited for the 11B, 11C, 19D or 19K MOSs during the study timeframe, additional female IET trainees were enrolled from other high physical demand BCT/AITs and OSUTs at Forts Sill and Leonard Wood. Total IET training time was MOS-dependent but ranged from 14–27 weeks.

4.3 OPAT Administration and Scoring

Enrolled trainees performed the OPAT testing within the first 2 weeks of beginning IET. Most testing was conducted while trainees were still in the reception station, prior to beginning IET. They reported to the testing location (i.e., indoor gymnasium) wearing the Army Physical Fitness Uniform (t-shirt, shorts, sneakers). Study personnel measured each trainees' height and weight without shoes. Then they completed all four OPAT events in a round-robin fashion, with the exception that the IAR was always performed last. The four field-expedient OPAT tests were assessments of upper- and lower-body muscular power (SPT and SLJ), lower-body muscular strength (SDL), and aerobic fitness (IAR). These events have been described in detail elsewhere (Foulis et al. 2015, Foulis et al. 2017); however, a brief explanation of each OPAT event is provided below.

4.3.1 Seated Power Throw (SPT)

As a measurement of upper-body muscular power, trainees were instructed to sit on the ground with their legs straight out in front of them and a foam block between their lower back and wall. Once seated, they were instructed to throw a 2-kilogram (kg) medicine ball as far as possible at a 45-degree angle from a resting position on their chest, while maintaining contact between their upper back and wall. No counter movement (i.e., rocking forward or backward) was allowed. Trainees were allowed two practice attempts and three attempts for record. The average distance of their two farthest throws were recorded (to the nearest 0.25 meter (m)) as their final performance.

4.3.2 Standing Long Jump (SLJ)

As a measurement of lower-body muscular power, trainees were instructed to stand with both feet placed parallel on a marked take-off line. Following a countermovement (arm swing with bent knees), trainees jump horizontally as far as possible. They were allowed two practice jumps followed by three recorded jumps. The average distance of their two farthest jumps was recorded (to the nearest 0.25 centimeters (cm)) as their final performance.

4.3.3 Strength Deadlift (SDL)

As a measurement of lower-body strength, trainees were instructed to stand inside a hexagon-barbell weighing 60 pounds (lb) unloaded (practice) or loaded with increasing weights. Upon verbal command from the test administrator, trainees were instructed to squat down, grasp the handles of the barbell, and lift the weight to a full hip extension while maintaining a neutral head and spine position. Trainees were first allowed to practice lifting form using the unloaded barbell

(60 lb) three times, where corrective feedback was provided. Afterwards, trainees advanced to each pre-set weight station in successive fashion (100, 140, 180, and 220 lb) and were allowed two attempts to lift the loaded hex bar. Rest was given between subsequent increasing loads (1 minute). The test was terminated when the trainee could not lift the loaded bar to the appropriate height with proper form within two attempts or decided to not attempt lifting a particular load. The highest weight tested was 220 lb, which did not represent a maximal lift for all subjects. The highest weight lifted with good form was recorded as their final score.

4.3.4 Interval Aerobic Run (IAR)

The IAR (i.e., beep test) is an incremental, multistage shuttle run that has been validated to estimate one's maximal aerobic capacity (e.g., maximal/peak oxygen consumption) (Leger et al. 1988). The test starts with individuals running between two lines 20 m apart and marked by cones (i.e., a shuttle). An audible signal ("beep") and voice "enforces" the speed and indicates the current level and number of shuttles achieved. The individual must reach the opposing line/cone within the time allowed for each shuttle. The initial speed was 8.5 kilometer per hour (~5.3 miles per hour), after which the speed for each 1-minute stage increased by 0.5 kilometer per hour (~0.3 miles per hour). Subjects were encouraged to provide maximal effort but were allowed to voluntarily stop the test at any time due to fatigue. Otherwise, the test was terminated if/when the individual failed to reach the opposing line before the next beep on two consecutive shuttles. Test administrators recorded the final number of shuttles successfully performed by the individual.

4.3.5 OPAT Scoring

TRADOC determined sex-neutral performance standards for the OPAT events based on the physical demand categories (PDCs) assigned to Army MOSs (DA 2016c). These PDCs are Black ('Heavy' physical demands), Gray ('Significant' physical demands), and Gold ('Moderate' physical demands). A fourth OPAT category, 'White,' designates individuals that did not meet the Army's lowest acceptable OPAT standard to enlist (i.e., Gold PDC) and would be considered 'currently unqualified.' These OPAT MOS categories and their assigned OPAT performance standards are presented in **Table 1** (DA 2016a).

Table 1. TRADOC Physical Demand Categories (PDC) and Requisite Occupational Physical Assessment Test (OPAT) Event Performance Standards

OPAT Physical Demand Category	Seated Power Throw (SPT)	Standing Long Jump (SLJ)	Strength Deadlift (SDL)	Interval Aerobic Run (IAR)
Black PDC (Heavy)	450 cm 14'9"	160 cm 5'3"	160 lb[a]	43 Shuttles (Stage 6-2)
Gray PDC (Significant)	400 cm 13'1"	140 cm 4'7"	140 lb	40 Shuttles (Stage 5-8)
Gold PDC (Moderate)	350 cm 11'6"	120 cm 3'11"	120 lb	36 Shuttles (Stage 5-4)
White (Currently Unqualified)	Any event score below the Gold (Moderate) standard			

Note:
[a] SDL weights tested in the current study were 60 lb (unloaded bar), 100 lb, 140 lb, 180 lb, and 220 lb

The TRADOC PDCs and score thresholds **(Table 1)** were used to categorize trainees' performance on the OPAT events. TRADOC established these event thresholds after our study protocol was approved and data collection had already begun. The pre-determined SDL weights assessed in the current study (60 lb, 100 lb, 140 lb, 180 lb, and 220 lb) did not align with the thresholds that TRADOC later established. For data analysis, we categorized SDL performance using three OPAT categories (Black PDC, Gray PDC, and White) and used the following SDL weight thresholds: Black PDC: ≥ 180 lb; Gray PDC: 140 lb; and White: ≤ 100 lb. The overall composite OPAT category was determined by the lowest event score and PDC achieved across all four events.

For additional analyses of OPAT event performance, sex-specific quartiles (Q) of performance were created for the SPT, SLJ, and IAR events (Q1 [lowest performers] to Q4 [highest performers]). For analyses of men and women combined, sex-neutral performance quartiles were created (Q1 to Q4) for these events. Because pre-determined weights were tested for the SDL event, performance quartiles could not be created; rather, three sex-specific and sex-neutral weight categories were used in analyses (≤140 lb, 180 lb, and 220 lb).

4.4 Injury Determination during IET

The length (weeks) of IET and type of training for enrolled trainees varied depending on their MOS. For men, OSUT (n=635) varied from 13 to 16 weeks and BCT-AIT (n=313) ranged from 16 to 19 weeks. Among women, OSUT (n=44) ranged from 14 to 19 weeks and BCT-AIT (n=189) ranged from 16 to 28 weeks. To minimize the effects of these differences in length and type of training, only the injuries that occurred during the first 10 weeks of IET (i.e., the period in which training was most similar for all trainees) were considered in this analysis. After 10 weeks, training in the OSUTs and AITs vary depending on the specific occupational skills and tasks required for each MOS.

Ambulatory medical encounter data for enrolled trainees were obtained from the Defense Medical Surveillance System [DMSS] and were provided by the Armed Forces Health Surveillance Branch (AFHSB) of the Defense Health Agency. These data included all medical visits during the course of training and included visit dates and diagnosis codes from the International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM). Musculoskeletal injury-related encounters were identified using the ICD-10-CM diagnosis codes included in the standardized "Installation Injury Report" [IIR] index. This index is routinely used by AFHSB and APHC for injury surveillance and research (USACHPPM 2004b). The musculoskeletal injury metric for this study was the cumulative injury incidence, defined as the percent of trainees with one or more injury encounters during the first 10 weeks of IET.

4.5 Attrition Determination during IET

We used the Army Training Resources and Requirements System [ATRRS] to track the IET completion status of study participants at two points in time: (1) at the end of the first 10 weeks of training ("10-week attrition") to coincide with the timeframe for injury analysis and (2) at the completion of BCT-AIT and OSUT ("final attrition"). For each timeframe, trainees were classified as either "attritted" (recycled for additional training or discharged for any reason) or "completed training" (successful completion of training).

4.6 Statistical Analyses

Descriptive statistics (i.e., central tendency metrics, percents, and frequencies) were used to describe trainee characteristics and OPAT performance. Body mass index (BMI) was calculated from the height and weight (BMI: body mass in kilograms per meter of height squared ($kg/m^{2)}$)). Estimated percent body fat was calculated from BMI with adjustment for sex and age (Gallagher et al. 2000). OPAT performance was described by: (1) the sex-neutral TRADOC PDC achieved on each OPAT event and the composite OPAT and (2) raw event performance means and raw event performance quartiles for the SPT, SLJ, and IAR events, and three weight categories for the SDL event. We used the Chi-square test of proportions or Fishers Exact test (when expected numbers were < 5) to compare equality of proportions (nominal data) and independent sample t-tests to evaluate differences between two means for continuous data. To evaluate linear trends, we use the Mantel-Haenszel Chi-square for trend in injury and attrition risk by OPAT performance groups. We also analyzed the raw event performance data by sex and injury or attrition status using analysis of variance (ANOVA).

IBM® SPSS® Statistics for Windows®, Version 25 was used for descriptive analyses and ANOVA. *Open Source Epidemiologic Statistics for Public Health*, (version www.OpenEpi.com, updated 2013/04/06; accessed 2018/03/08) was used to evaluate univariate associations (relative risk [RR]; 95% confidence interval [CI]) for the associations of OPAT event performance with injury and attrition. For all statistical analyses, $\alpha \leq 0.05$ was set a priori.

5 RESULTS

5.1 Characteristics of IET Trainees

A total of 1,181 IET Trainees (men: n = 948; women: n = 233) participated in the OPAT testing. Overall, 33% of men and 81% of women were in BCT-AIT, while the remainder were enrolled in one of the OSUTs. Trainee characteristics are presented in **Table 2.** On average, there was no significant difference in age between the sexes (p=0.12), but there were differences in the physical characteristics by sex. Men were taller, heavier, and had a higher mean BMI, but women had a higher percent body fat (adjusted for age and sex).

Table 2. Characteristics of Initial Entry Training (IET) Trainee Volunteers

Characteristic	Men (n=948) Mean ± SD	Women (n=233) Mean ± SD	p-value[a]
Age (years)	20.8 ± 3.1	20.4 ± 2.9	0.12
Height (cm)	175.4 ± 6.6	162.6 ± 6.0	<.001
Mass (kg)	78.6 ± 13.0	63.1 ± 8.3	<.001
BMI (kg/m^2)	25.5 ± 3.7	23.9 ± 2.7	<.001
Body Fat (%)	18.4 ± 4.8	30.1 ± 4.3	<.001

Note:
[a] p-value, independent t-test comparing mean characteristics of men and women
SD, standard deviation

5.2 OPAT Performance Stratified by PDC

Table 3 presents the distributions of trainee performance on the composite OPAT and the individual events stratified by the TRADOC PDCs**.** In the analysis with sexes combined, 55% of trainees achieved the Black PDC. But when men and women were examined separately, there were significant differences (p<0.001) in the distributions by PDC for the composite OPAT and for each of the events individually. Generally, larger proportions of men met the standards for the Black PDC and larger proportions of women were classified in the White category. On the composite OPAT, 87.3% of men achieved at least the Gold PDC standard (Black, Gray, and Gold, combined) compared to 32.6% of women (p<0.001).

Table 3. Distribution of Occupational Physical Assessment Test (OPAT) Performance by Physical Demand Category (PDC)

OPAT Event	PDC (Cut-points)	Combined (n=1,181)		Men (n=948)		Women (n=233)		p-value[a]
		n	(%)	n	(%)	n	(%)	
Overall OPAT	Black	655	55.5	639	67.4	16	6.9	**<0.01**
	Gray	146	12.4	125	13.2	21	9.0	
	Gold	103	8.7	64	6.8	39	16.7	
	White	277	23.5	120	12.7	157	67.4	
SPT (cm)	Black (450)	966	81.8	928	97.9	38	16.3	**<0.01**
	Gray (400)	76	6.4	17	1.8	59	25.3	
	Gold (350)	96	8.1	3	0.3	93	39.9	
	White (<350)	43	3.6	0	0.0	43	18.5	
SLJ (cm)	Black (160)	929	78.7	858	90.5	71	30.5	**<0.01**
	Gray (140)	135	11.4	64	6.8	71	30.5	
	Gold (120)	93	7.9	24	2.5	69	29.6	
	White (<120)	24	2.0	2	0.2	22	9.4	
SDL (lb)	Black (180)	1042	88.2	915	96.5	127	54.5	**<0.01**
	Gray (140)	103	8.7	25	2.6	78	33.5	
	White (<120)	36	3.0	8	0.8	28	12.0	
IAR (shuttles)	Black (43)	741	62.7	692	73.0	49	21.0	**<0.01**
	Gray (40	105	8.9	87	9.2	18	7.7	
	Gold (36)	76	6.4	53	5.6	23	9.9	
	White (<36)	259	21.9	116	41.4	143	61.4	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift (3 categories tested: Black, Gray, and White); IAR = Interval Aerobic Run
[a] p-value, Chi-square comparing distribution by PDC between the sexes **(Bold: p<0.05)**

To further investigate event performance, we examined the raw event performance on the OPAT events **(Table 4)**. Event performance was described by the mean ± SD for the SPT, SLJ, and IAR events and by the number and proportion of trainees within group that lifted each weight (i.e., maximum weight lifted) on the SDL event. Comparing performance between sexes, women performed at a lower level than men on all events. On the SPT event, for example, women on average threw the medicine ball 206 cm (-34.7%) shorter distance. Similarly, women on average jumped 50 cm (-25.2%) shorter distance on the SLJ and did 23 (-40.5%) fewer IAR shuttles. On the SDL event, 13.3% of women (-75.5% fewer) lifted the heaviest weight (220 lb) compared to 86.8% of men (p<0.001).

Table 4. Occupational Physical Assessment Test (OPAT) Event Performance

OPAT Event	Combined (n = 1,181) Mean ± SD	Men (n = 948) Mean ± SD	Women (n = 233) Mean ± SD	p-value[a]
SPT (cm)	552.6 ± 111.9	593.2 ± 81.1	387.4 ± 51.4	**<0.01**
SLJ (cm)	189.5 ± 34.9	198.4 ± 29.8	148.3 ± 23.5	**<0.01**
IAR (shuttles)	51.2 ± 19.5	55.6 ± 18.0	33.1 ± 14.3	**<0.01**
SDL	**n (%)**	**n (%)**	**n (%)**	**p-value[b]**
60 lb	3 (0.3)	1 (0.1)	2 (0.9)	
100 lb	33 (2.8)	7 (0.7)	26 (11.2)†	
140 lb	103 (8.7)	25 (2.6)	78 (33.5)†	**<0.01**
180 lb	188 (15.9)	92 (9.7)	96 (41.2)†	
220 lb	854 (72.3)	823 (86.8)	31 (13.3) †	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift;
IAR = Interval Aerobic Run
[a] p-value, independent t-test comparing mean performance between sexes **(Bold: p<0.05)**
[b] p-value, Chi-square comparing distribution of men and women **(Bold: p<0.05)**
† p-value <0.001 for difference between proportions of men and women in the SDL weight category

5.3 Injuries during First 10 Weeks of IET

For the BCT-AIT and OSUT groups, injuries were tracked during the first 10 weeks of IET since the training is similar for all trainees during this period. The injury case definition was a trainee that had one or more medical encounters for a musculoskeletal injury during the 10-week period. Overall, 32% of men (n=297) and 47% of women (n=110) had an injury during the first 10 weeks of IET **(Table 5)**, and injury risk for women was 1.5 times higher than for men. Among women, there was a significant trend for increasing injury incidence with each successively older age group (p=0.02). Among men, but not women, OSUT trainees had a 1.9 times higher (p<0.01) injury risk compared to trainees in BCT-AIT. Among men, there was a U-shaped pattern for the association of BMI and injury with men in Q1 and Q3 having 1.4 (p=0.04) and 1.3 (p=0.05) times higher risk of injury, respectively, compared to men in Q2 (quartile most closely aligned with generally accepted U.S. standard for “normal” BMI).

Table 5. Ten-Week Injury Incidence and Association with Trainee Characteristics

Trainee Characteristics	Trainee Group											
	Combined (n=1,181)				Men (n=948)				Women (n=233)			
	n	Injured %	Risk Ratio (95% CI)	p-value	n	Injured %	Risk Ratio (95% CI)	p-value	n	Injured %	Risk Ratio (95% CI)	p-value
Sex												
Men	948	31.5	1.00	**<0.001**	948	31.5	--	--				
Women	233	47.2	1.51 (1.28-1.78)						233	47.2	--	--
Age (years)												
<20	547	32.7	1.00		424	30.7	1.00		123	39.8	**1.00[b]**	
20-24	499	34.7	1.06 (0.89-1.26)	0.51	414	30.7	1.00 (0.82-1.23)	0.99	85	54.1	**1.36 (1.01-1.82)[b]**	**0.04**
≥25	132	40.9	1.25 (0.99-1.59)	0.08	107	36.4	1.19 (0.89-1.59)	0.25	25	60.0	**1.51 (1.02-2.22)[b]**	0.06
Training Type												
BCT-AIT	502	29.3	1.00		313	19.5	1.00		189	45.5	1.00	
OSUT	679	38.3	**1.31 (1.11-1.54)**	**<0.01**	635	37.2	**1.91 (1.49-2.44)**	**<0.01**	44	54.5	1.20 (0.88-1.64)	0.28
BMI Quartiles (Q)[c]												
Q1(lowest)					235	34.5	**1.35 (1.02-1.78)**	**0.04**	58	39.7	0.74 (0.50-1.11)	0.14
Q2					238	25.6	1.00		58	53.4	1.00	
Q3					236	33.9	**1.32 (1.00-1.75)**	**0.05**	58	50	0.94 (0.66-1.33)	0.71
Q4 (highest)					238	31.1	1.21 (0.91-1.62)	0.19	59	45.8	0.86 (0.59-1.24)	0.41
Body Fat Quartiles[d]												
Q1 (lowest)	295	31.2	1.03 (0.81-1.31)	0.81	236	33.5	1.23 (0.94-1.63)	0.13	58	37.9	0.69 (0.46-1.03)	0.06
Q2	294	30.3	1.00		236	27.1	1.00		58	55.2	1.00	
Q3	293	32.1	1.06 (0.83-1.35)	0.64	236	30.5	1.13 (0.85-1.50)	0.42	59	50.8	0.92 (0.65-1.30)	0.64
Q4 (highest)	295	44.1	**1.46 (1.17-1.81)**	**<0.01**	236	33.9	1.25 (0.95-1.65)	0.11	58	44.8	0.81 (0.56-1.17)	0.27

Notes:

[a] p-value for Risk Ratio (**Bold**: $p \leq 0.05$)

[b] p=0.02 (**Bold**), Mantel-Haenszel Chi-square for trend of higher injury risk by age groups (women)

[c] BMI Quartile Cut-points:

BMI: Male Quartiles: Q1: ≤22.69; Q2: 22.70; Q3: 25.26; Q4: ≥28.19

BMI: Female Quartiles: Q1: ≤21.75; Q2: 21.76; Q3: 24.21; Q4: ≥25.93

[d] Body Fat Quartiles Cut-points:

Body Fat Male Quartiles: Q1: ≤15.04; Q2: 15.05; Q3: 18.69; Q4: ≥22.03

Body Fat Female Quartiles: Q1: ≤27.23; Q2: 27.24; Q3: 30.98; Q4: ≥33.29

Body Fat Combined Quartiles: Q1: ≤16.04; Q2: 16.06; Q3: 20.42; Q4: ≥24.47

5.4 Association of OPAT Performance and Injury during First 10 Weeks of IET

We investigated prospectively the association of OPAT performance at the beginning of IET and injuries that occurred during the first 10 weeks of IET. Since the OPAT was developed as a tool to assess the physical capacity of all recruits based on sex-neutral performance standards, we first examined the OPAT-injury association with the sexes combined. **Table 6** summarizes the association of OPAT performance and injury for the sexes combined. OPAT performance is stratified by PDC (upper portion of the **Table 6**) and then by raw event performance bins (lower portion of the table).

When OPAT performance was stratified by PDCs (upper portion of **Table 6**) for the combined sex analysis, injury risk was related to OPAT performance. For the composite OPAT, trainees in the Gray PDC and White category had significantly higher injury risk compared to trainees that met the Black standard (Gold PDC: 1.4 times higher, $p=0.02$; White: 1.8 times higher, $p<0.01$). On the SLJ and SDL events, there were significant linear trends ($p<0.001$ for each event) for higher injury risk going from the highest performance category (i.e., Black PDC) to the lowest category (i.e., White). Even though no such trend was present for the IAR event, trainees in the Gray PDC and White category did have significantly higher injury risk (Gray: 1.5 times higher, $p<0.01$; White: 1.8 times higher, $p<0.01$) compared to trainees that met the standard for the Black PDC.

To further evaluate the association of OPAT performance and injuries with sexes combined, we stratified performance by raw event performance bins (sex-neutral performance quartiles for the SPT, SLJ, and IAR events; 3 performance categories for the SDL event) for men and women, combined (lower portion of **Table 6**). There were significant trends on the SPT ($p=0.01$), SDL ($p<0.001$), and IAR ($p<0.001$) events for higher injury risk as performance decreased from the highest to the lowest performance bin, but on the SPT event, only the lowest performance bin had a significantly higher injury risk. Injury risks for the lowest performers (SPT, SLJ, and IAR events: Q1; SDL event: ≤ 140 lb) ranged from 1.4 to 1.8 times higher ($p=0.01$ to $p<0.01$, by event) compared to the highest event performers (SPT, SLJ, and IAR events: Q4; SDL event: 220 lb).

Considering the differences by sex in OPAT performance (Table 3 and 4) and injury risk (Table 5), we repeated the above analysis by OPAT PDC categories and raw event performance for men and women, separately. Injury incidence and risk ratios stratified by OPAT PDCs are presented in **Table 7**. In this and subsequent tables, the "‡" indicates that the Fisher exact test was used to evaluate differences in proportions instead of the Chi-square test due to low-expected cell counts. In these instances, 95% CIs for the RRs could not be calculated. Overall, the composite OPAT was associated with injury risk among men but not significantly among women. Compared to men that achieved the Black PDC standard on the composite OPAT, men in the Gray PDC and White category had significantly higher injury risk (1.4 ($p=0.02$) and 1.6 ($p<0.01$) times higher, respectively). Of the four singular events among men and women, only the IAR event was associated with injury risk. Compared to trainees that met the Black PDC standard for the IAR, men in the Gray, Gold, and White categories had significantly higher injury risk (1.7 ($p<0.01$), 1.5 ($p=0.03$), and 1.5 ($p<0.01$) times higher risk, respectively); whereas,

among women, only those in the White category for the IAR had a significantly higher injury risk (1.5 times higher risk; p=0.02). Among men, there was also increased injury risk on the SDL for trainees in the White category compared to those in the Black PDC; however, because of the small number of trainees in the White category, this finding should be considered tentative.

Next, we explored the 10-week injury incidence stratified by raw event performance bins for men and women, separately **(Table 8)**. Performance bins for the SPT, SLJ, and IAR events were defined by quartiles (Q1=lowest; Q4=highest performance); bins for the SDL event were three categories of maximum weight lifted. There was evidence for the association of OPAT raw performance and injury on the SDL and the IAR events. On the SDL event, men that lifted 180 lb had a 1.4 times higher injury risk (p=0.01) compared to those that lifted the heaviest weight tested (220 lb). Among women, injury risk was 1.9 times higher for those that lifted 180 lb (p=0.02) and 2.0 times higher for those that lifted 140 lb (p=0.01), compared to women that lifted the heaviest weight tested (220 lb). On the IAR event, injury risks for men and women in the lowest performance quartile (Q1) were 1.6 (p<0.01) and 1.8 (p<0.01) times higher, respectively, compared to the highest performance quartile (Q4) within sex.

To further explore differences in injury risk by event performance, we compared the raw event performance between injured and uninjured trainees, first with the sexes combined, then separately **(Table 9)**. Event performance was described by the mean ± SD for the SPT, SLJ, and IAR events and by the number (and percent) that lifted a given maximal load. In the analysis with sexes combined, trainees that were eventually injured in training performed at a significantly lower level (p<0.001) on all four events compared to uninjured trainees. But on further evaluation with the 2-way ANOVA, there was a main effect of sex on the SPT, SLJ, and IAR events with no interaction effects between sex and injury. To account for this effect of sex, we performed the same comparison of injured and uninjured trainees among men and women, separately. On the SPT and SLJ events, performance was not different between injured/uninured groups among men or women; however, on the IAR (men and women) and SDL (men) events, there were small but significant differences between injured/uninjured groups within each sex. Compared to uninjured trainees within sex, injured men on average completed 5 fewer (-8.2%) IAR shuttles (p<0.01) and 7.5% fewer injured men (p<0.001) lifted the heaviest SDL weight (220 lb; p<0.001); injured women on average completed 7 fewer (-19.9%) IAR shuttles (p<0.01).

Table 6. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Physical Demand Category (PDC) and Raw Performance Bins with Injuries during 10 Weeks of Initial Entry Training (IET), Sexes Combined

OPAT Event	PDC Cut-points or Performance Cut-points	Combined (n=1,181)			
		n	Injured (%)	Risk ratio (95% CI)	p-value
Overall OPAT	Black	655	27.8	1.00	
	Gray	146	37.7	**1.36 (1.06-1.73)**	**0.02**
	Gold	103	33.0	1.19 (0.88-1.61)	0.28
	White	277	49.1	**1.77 (1.49-2.10)**	**<0.01**
SPT (cm)	Black (450)	966	32.0	1.00	
	Gray (400)	76	39.5	1.23 (0.92-1.65)	0.18
	Gold (350)	76	39.5	1.23 (0.92-1.65)	0.18
	White (<350)	43	46.5	**1.45 (1.04-2.03)**	**0.05**
SLJ (cm)	Black (160)	929	32.0	1.00[a]	
	Gray (140)	135	40.7	**1.27 (1.02-1.59)[a]**	**0.04**
	Gold (120)	93	44.1	**1.38 (1.08-1.77)[a]**	**0.02**
	White (<120)	24	58.3	**1.83 (1.29-2.59)[a]**	**0.01**
SDL (lb)	Black (180)	1042	32.5	**1.00[a]**	
	Gray (140)	103	45.6	**1.40 (1.12-1.76)[a]**	**0.01**
	White (<120)	36	58.3	**1.79 (1.34-2.40)[a]**	**<0.01**
IAR (shuttles)	Black (43)	741	27.8	1.00	
	Gray (40)	105	41.9	**1.51 (1.17-1.94)**	**<0.01**
	Gold (36)	76	38.2	1.37 (1.01-1.87)	0.06
	White (<36)	259	49.4	**1.78 (1.50-2.11)**	**<0.01**
SPT (cm)	Q1: ≤488	313	40.9	**1.37 (1.09-1.71)[a]**	**0.01**
	Q2: 489	278	34.2	1.14 (0.89-1.46)[a]	0.29
	Q3: 564	316	32.3	1.08 (0.85-1.37)[a]	0.54
	Q4: ≥626	274	29.9	1.00[a]	
SLJ (cm)	Q1: ≤164.00	300	45.0	**1.54 (1.24-1.91)**	**<0.01**
	Q2: 164.01	299	36.1	1.24 (0.98-1.56)	0.07
	Q3: 190.51	288	27.1	0.93 (0.71-1.20)	0.56
	Q4: ≥212.51	294	29.3	1.00	
SDL (lb)	≤140	139	48.9	**1.66 (1.36-2.02)[a]**	**<0.01**
	180	188	46.3	**1.57 (1.30-1.89)[a]**	**<0.01**
	220	854	29.5	1.00[a]	
IAR (shuttles)	Q1: ≤38	309	46.3	**1.81 (1.44-2.28)[a]**	**<0.01**
	Q2: 39	295	36.9	**1.44 (1.13-1.85)[a]**	**<0.01**
	Q3: 51	288	28.1	1.10 (0.84-1.44)[a]	0.49
	Q4: ≥64	289	25.6	1.00[a]	

Notes:
Bold: p-value for Risk Ratio ≤0.05
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift (3 categories tested: Black, Gray, and White); IAR = Interval Aerobic Run
[a] p<0.01 for linear trend (Mantel-Haenszel Chi-square test for trend)

Table 7. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Physical Demand Category (PDC) and Injuries during 10 Weeks of Initial Entry Training (IET) among Men and Women

		Men (n=948)				Women (n=233)			
OPAT Event	**PDC (Cut-points)**	**n**	**Injured (%)**	**Risk ratio (95% CI)**	**p-value**	**n**	**Injured (%)**	**Risk ratio (95% CI)**	**p-value**
Overall OPAT	Black	639	27.4	1.00		16	43.8	1.00	
	Gray	125	37.6	**1.37 (1.06-1.78)**	**0.02**	21	38.1	0.87 (0.40-1.90)	0.73
	Gold	64	37.5	1.37 (0.97-1.93)	0.09	39	25.6	0.59 (0.27-1.27)	0.19
	White	120	42.5	**1.55 (1.22-1.98)**	**<0.01**	157	54.1	1.24 (0.70-2.20)	0.43
SPT (cm)	Black (450)	928	31.5	1.00		38	44.7	1.00	
	Gray (400)	17	23.5	0.75 (0.32-1.17)	0.48	59	44.1	0.99 (0.62-1.55)	0.95
	Gold (350)	3	33.3	1.06‡	0.99‡	93	50.5	1.13 (0.75-1.70)	0.55
	White (<350)	0	0.0	--	--	43	46.5	1.04 (0.65-1.68)	0.87
SLJ (cm)	Black (160)	858	30.9	1.00		71	45.1	1.00	
	Gray (140)	64	35.9	1.16 (0.83-1.64)	0.48	71	45.1	1.00 (0.70-1.44)	0.99
	Gold (120)	24	37.5	1.21 (0.72-2.06)	0.49	69	46.4	1.03 (0.72-1.48)	0.88
	White (<120)	2	0.0	--	--	22	63.6	1.41 (0.94-2.12)	0.13
SDL (lb)	Black (180)	915	30.9	1.00		127	44.1	1.00	
	Gray (140)	25	28.0	0.91 (0.48-1.71)	0.75	78	51.3	1.16 (0.87-1.56)	0.32
	White (<120)	8	87.5	**2.83‡**	**<0.01‡**	28	50.0	1.13 (0.75-1.72)	0.57
IAR (shuttles)	Black (43)	692	27.2	1.00		49	36.7	1.00	
	Gray (40)	87	44.8	1.65 (1.27-2.15)	**<0.01**	18	27.8	0.76 (0.33-1.74)	0.49
	Gold (36)	53	41.5	1.53 (1.09-2.15)	**0.03**	23	30.4	0.83 (0.40-1.70)	0.60
	White (<36)	116	41.4	1.52 (1.19-1.95)	**<0.01**	143	55.9	**1.52 (1.03-2.26)**	**0.02**

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift (3 categories tested: Black, Gray, and White); IAR = Interval Aerobic run
Bold: p-value for Risk Ratio ≤0.05
-- Dashed lines indicates that RR and p-values were not calculated due to 0 counts of incidence in the comparison group.
‡ At least one expected value was <5. Fisher exact test was used for p-value; unable to calculate confidence interval for risk ratio.

Table 8. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Raw Performance Bins and Injuries during 10 Weeks of Initial Entry Training (IET) among Men and Women

OPAT Event	Men (n=948)					Women (n=233)				
	Performance Cut-points	n	Injured (%)	Risk Ratio (95% CI)	p-value	Performance Cut-points	n	Injured (%)	Risk Ratio (95% CI)	p-value
SPT (cm)	Q1: ≤538	252	31.7	1.03 (0.79-1.34)	0.82	Q1: ≤350	75	45.3	1.11 (0.73-1.69)	0.62
	Q2: 539	242	34.3	1.11 (0.86-1.44)	0.41	Q2: 351	44	54.5	1.34 (0.87-2.06)	0.19
	Q3: 589	217	28.1	0.91 (0.69-1.22)	0.53	Q3: 376	65	49.2	1.21 (0.79-1.83)	0.37
	Q4: ≥645	237	30.8	1.00		Q4: ≥426	49	40.8	1.00	
SLJ (cm)	Q1: ≤178.00	238	37.0	1.22 (0.95-1.58)	0.12	Q1: ≤131.50	60	50.0	1.19 (0.80-1.76)	0.39
	Q2: 178.01	238	30.7	1.02 (0.77-1.33)	0.91	Q2: 131.51	58	53.4	1.27 (0.86-1.87)	0.22
	Q3: 198.51	237	27.4	0.91 (0.68-1.21)	0.50	Q3: 145.51	58	43.1	1.02 (0.67-1.57)	0.91
	Q4: ≥218.01	235	30.2	1.00		Q4: ≥164.51	57	42.1	1.00	
SDL (lb)	≤140	33	42.4	1.43 (0.95-2.16)	0.12	≤140	106	50.9	**1.97 (1.06-3.69)**	**0.01**
	180	92	42.4	**1.43 (1.10-1.86)**	**0.01**	180	96	50.0	**1.94 (1.03-3.64)**	**0.02**
	220	823	29.6	1.00		220	31	25.8	1.00	
IAR (shuttles)	Q1: ≤42	256	42.6	**1.57 (1.22-2.02)**	**<0.01**	Q1: ≤23	60	65.0	**1.77 (1.17-2.67)**	**<0.01**
	Q2: 43	238	27.7	1.02 (0.76-1.37)	0.88	Q2: 24	59	54.2	1.48 (0.95-2.28)	0.07
	Q3: 54	218	26.6	0.98 (0.72-1.33)	0.90	Q3: 32	65	32.3	0.88 (0.53-1.46)	0.62
	Q4: ≥67	236	27.1	1.00		Q4: ≥43	49	36.7	1.00	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift; IAR = Interval Aerobic Run
Bold: p-value for Risk Ratio ≤0.05

Table 9. Raw Occupational Physical Assessment Test (OPAT) Event Performance Stratified by 10-Week Injury Status

	Trainee Group								
	Combined (n=1,181)			Men (n=948)			Women (n=233)		
OPAT Event	**Injured (n=407) Mean ± SD**	**Not Injured (n=774) Mean ± SD**	**p-value[a]**	**Injured (n=297) Mean ± SD**	**Not Injured (n=651) Mean ± SD**	**p-value[a]**	**Injured (n=110) Mean ± SD**	**Not Injured (n=123) Mean ± SD**	**p-value[a]**
SPT (cm)	535.6 ± 115.7	561.6 ± 108.8	**<0.001**	591.4 ± 76.4	594.0 ± 83.3	0.64	384.9 ± 50.6	389.7 ± 52.3	0.47
SLJ (cm)	182.6 ± 35.8	191.6 ± 34.1	**<0.001**	195.8 ± 29.8	199.6 ± 29.8	0.07	146.9 ± 24.8	149.5 ± 22.3	0.40
IAR (shuttles)	46.1 ± 19.7	53.8 ± 18.9	**<0.001**	52.4 ± 18.17	57.1 ± 17.8	**<0.01**	29.3 ± 12.6	36.6 ± 14.8	**<0.01**
SDL	**n (%)**	**n (%)**	**p-value[b]**	**n (%)**	**n (%)**	**p-value[b]**	**n (%)**	**n (%)**	**p-value[b]**
60 lb	3 (0.7)	0 (0.0)		1 (0.3)	0 (0.0)		2 (1.8)	0 (0.0)	
100 lb	18 (4.4) †	15 (1.9)		6 (2.0) †	1 (0.2)		12 (10.9)	14 (11.4)	
140 lb	47 (11.5) †	56 (7.2)	**<0.001**	7 (2.4)	18 (2.8)	**<0.001**	40 (36.4)	38 (30.9)	0.07
180 lb	87 (21.4) †	101 (13.0)		39 (13.1) †	53 (8.1)		48 (43.6)	48 (39.0)	
220 lb	252 (61.9)	602 (77.8) †		244 (82.2)	579 (88.9) †		8 (7.3)	23 (18.7) †	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; IAR = Interval Aerobic Run; SDL = Strength Deadlift
[a] p-value, t-test comparing mean performance of injured and not injured trainees (**Bold**: p-value ≤0.05)
[b] p-value, Chi-square comparing distribution of injured and not injured trainees (**Bold**: p-value ≤0.05)
† p-value <0.05 for difference between proportions of injured and not injured trainees in the SDL weight category

5.5 Association of the OPAT and Attrition during First 10 Weeks of IET

The 1,181 trainees (men: n=948; women: n=233) that took the OPAT at the beginning of IET were tracked for attrition (i.e., recycled for additional training or discharged) during two timeframes: (1) first 10 weeks of IET (same timeframe as used in the OPAT-injury analysis) and 2) completion of IET. Findings for the association of the OPAT and attrition during the first 10 weeks of IET are summarized in this section.

The 10-week attrition incidence stratified by trainee characteristics is presented in **Table 10**. Overall, 6.7% of trainees attritted during this timeframe. The proportions of men (6.5%; n=62) and women (7.3%; n=17) that attritted were similar (p=0.68). Attrition among men in BCT-AIT was 1.8 times higher (p=0.02) than among men in OSUT; 9% of women in BCT-AIT attritted compared to none of the OSUT women. Attrition among male and female trainees that had an injury during the 10-week timeframe was 2.5 (p<0.01) and 5.2 (<0.01) times higher, respectively, compared to uninjured trainees within sex.

Since the OPAT was developed as a tool to assess the physical capacity of all recruits based on sex-neutral performance standards, we first examined the association of OPAT performance and attrition among men and women combined. **Table 11** summarizes the association of OPAT performance and attrition stratified by PDC (upper portion of the table) and by raw event performance bins (lower portion of the table). With OPAT performance stratified by PDC for the composite OPAT, trainees in the White category had a 2.2 times higher attrition risk (p<0.01) compared to trainees that met the Black PDC standard. Similarly, trainees in the White category for the SPT and IAR events had significantly higher attrition (2.7 (p=0.01) and 2.3 (p<0.01) times higher, respectively) compared to trainees that met the Black PDC standard.

In the lower portion of **Table 11** (sexes combined), raw event performance is stratified by performance bins (quartiles for SPT, SLJ, and IAR events; three categories of weight lifted for the SDL event). For the SLJ event, there was a significant trend (p<0.01) for higher attrition risk associated with lower performance going from Q4 to Q1; attrition risk was 2.3 times higher (p=0.01) for the lowest performers (Q1) compared to the highest performers (Q4). The lowest performers on the IAR event (Q1) had a 2.1 times higher attrition risk (p=0.01) compared to the highest performers (Q4) but without evidence of a linear trend.

Considering the differences by sex in OPAT performance (Tables 3 and 4), we repeated the above analyses for men and women, separately. In **Table 12**, OPAT performance was stratified by OPAT PDCs. With the low attrition incidence in 10 weeks among both sexes, the number and proportion of trainees that attritted by PDC were small. Among men, the data were sufficient to calculate relative risks for the composite OPAT and the IAR event, but this was not the case among women. Men in the White categories for the composite OPAT and the IAR event had a 2.5 (p<0.01) and 2.7 (p<0.01) times higher risk for attrition, respectively, compared to trainees that met the respective Black PDC standard.

Next, OPAT performance was stratified by raw OPAT event performance bins among men and women, separately **(Table 13).** Performance bins were the same as described previously. In this

analysis among women, the attrition data were too sparse to be able to calculate confidence intervals for risk ratios. Among men, there were significant trends for the SLJ ($p=0.01$) and IAR ($p<0.001$) events where the risk of attrition increased as the event performance decreased from the highest performance bin (Q4) to the lowest performance bin (Q1). Specifically, men in Q1 for the SLJ and IAR events had 2.2 ($p=0.03$) and 3.0 ($p<0.01$) times higher attrition compared to men in Q4 of the respective event.

We then compared differences in OPAT performance between trainees that eventually attritted within 10 weeks and those that completed 10 weeks of training **(Table 14).** In the analysis with the sexes combined, trainees that attritted performed at a significantly lower level on the SLJ ($p<0.01$) and IAR ($p<0.001$) events. But on further evaluation with the ANOVA, we found a main effect of sex on performance on all events (ANOVA: $p<0.001$ on each event), with no interaction effects between sex and attrition. To account for the effect of sex, we performed the same comparisons within each sex. Among men, those that attritted during the first 10 weeks of IET performed at a lower mean performance level on the SLJ ($p=0.02$) and IAR ($p=0.001$) events compared to men that completed 10 weeks of training. These differences were 10 cm shorter (-4.8%) jump on the SLJ event and 8 fewer (-13.4%) IAR shuttles. Among women, trainees that attritted performed at a lower level on the SPT ($p=0.02$), IAR ($p=0.001$), and SDL ($p=0.05$) events compared to women that completed 10 weeks of training. These differences, relative to women that completed training, were 30.6 cm shorter (-7.9%) throw on the SPT event and 11 fewer (-33.5%) IAR shuttles. On the SDL event, 20.8% fewer women that attritted lifted the two heaviest weights (180 lb and 220 lb, combined) compared to women that completed 10 weeks of training.

Table 10. Ten-Week Attrition Incidence and Association with Trainee Characteristics

	Trainee Group											
	Combined (n=1,181)				Men (n=948)				Women (n=233)			
Characteristic	**n**	**Attritted (%)**	**Risk Ratio (95% CI)**	**p-value**	**n**	**Attritted (%)**	**Risk Ratio (95% CI)**	**p-value**	**n**	**Attritted (%)**	**Risk Ratio (95% CI)**	**p-value**
Sex												
Men	948	6.5	1.00		948	6.5						
Women	233	7.3	1.11 (0.67-1.87)	0.68					233	7.3		
Age (years)												
<20	547	5.7	1.00		424	5.0	1.00		123	8.1	1.00	
20-24	499	7.6	1.34 (0.85-2.13)	0.21	414	7.7	1.56 (0.92-2.66)	0.10	85	7.1	0.86 (0.33-2.30)	0.77
≥25	132	6.8	1.20 (0.59-2.47)	0.61	107	7.5	1.51 (0.69-3.31)	0.31	25	4.0	0.49‡	0.83‡
Training Type												
BCT-AIT	502	9.2	**1.89 (1.22-2.90)**	**<0.01**	313	9.3	**1.78 (1.10-2.88)**	**0.02**	189	9.0	--	--
OSUT	679	4.9	1.00		635	5.2	1.00		44	0.0	--	--
Injured[a]												
No	774	4.1	1.00		651	4.5	1.00		123	2.4	1.00	
Yes	407	11.5	**2.79 (1.81-4.31)**	**<0.001**	297	11.1	**2.49 (1.54-4.03)**	**<0.01**	110	12.7	**5.22 (1.54-17.68)**	**<0.01**

Notes:

Bold: p-value for Risk Ratio ≤0.05

-- Dashed lines indicates that RR and p-values were not calculated due to 0 counts of incidence in the comparison group.

[a] Injured during the first 10 weeks of IET

‡ At least one expected value was <5. Fisher exact test was used for p-value; unable to calculate confidence interval for risk ratio.

Table 11. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Physical Demand Category (PDC) and Raw Performance Bins with 10-Week Attrition, Sexes Combined

OPAT Event	PDC Cut-point or Performance Cut-points	Combined (n=1,181)			
		n	Attritted (%)	Risk ratio (95% CI)	p-value
Overall OPAT	Black	655	5.3	1.00	
	Gray	146	6.2	1.15 (0.57-2.35)	0.69
	Gold	103	2.9	0.55 (0.17-1.74)	0.29
	White	277	11.6	**2.16 (1.37-3.42)**	**<0.01**
SPT (cm)	Black (450)	966	6.1	1.00	
	Gray (400)	76	6.6	1.08‡	0.99‡
	Gold (350)	94	8.3	1.36 (0.67-2.77)	0.39
	White (<350)	43	16.3	**2.67 (1.30-5.48)**	**0.01**
SLJ (cm)	Black (160)	929	5.9	1.00	
	Gray (140)	135	9.6	1.63 (0.91-2.90)	0.10
	Gold (120)	93	7.5	1.27 (0.60-2.71)	0.54
	White (<120)	24	16.7	2.82 (‡)	0.11‡
SDL (lb)	Black (≥180)	1042	6.3	1.00	
	Gray (140)	103	6.8	1.07 (0.51-2.28)	0.85
	White (<120)	36	16.7	2.63‡	0.06‡
IAR (shuttles)	Black (43)	741	5.1	1.00	
	Gray (40)	105	6.7	1.30 (0.60-2.84)	0.51
	Gold (36)	76	3.9	0.77‡	0.92‡
	White (<36)	259	12.0	**2.33 (1.48-3.67)**	**<0.01**
SPT (cm)	Q1: ≤488	313	7.0	1.07 (0.59-1.95)	0.83
	Q2: 489	278	8.3	1.26 (0.70-2.28)	0.45
	Q3: 564	316	5.1	0.77 (0.40-1.48)	0.43
	Q4: ≥626	274	6.6	1.00	
SLJ (cm)	Q1: ≤164.00	300	9.3	**2.29 (1.19-4.41)[a]**	**0.01**
	Q2: 164.01	299	8.0	**1.97 (1.00-3.86)[a]**	**0.04**
	Q3: 190.51	288	5.2	1.28 (0.61-2.68)[a]	0.52
	Q4: ≥212.51	294	4.1	1.00[a]	
SDL (lb)	≤140	139	9.4	1.54 (0.86-2.75)	0.15
	180	188	7.4	1.22 (0.69-2.16)	0.49
	220	854	6.1	1.00	
IAR (shuttles)	Q1: ≤38	309	10.4	**2.14 (1.17-3.92)**	**0.01**
	Q2: 39	295	7.5	1.54 (0.80-2.95)	0.19
	Q3: 51	288	3.8	0.79 (0.36-1.71)	0.55
	Q4: ≥64	289	4.8	1.00	

Notes:
Bold: p-value for Risk Ratio ≤.05
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift (3 categories tested: Black, Gray, and White); IAR = Interval Aerobic Run
-- Dashed lines indicates that RR and p-values were not calculated
‡At least one expected value was <5. Fisher exact test was used for p-value; unable to calculate confidence interval for risk ratio.
[a] p<0.01 for linear trend (Mantel-Haenszel Chi-square test for trend)

Table 12. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Physical Demand Category (PDC) and 10-Week Attrition among Men and Women

		Men (n=948)				Women (n=233)			
OPAT Event	**PDC Cut-points**	**n**	**Attritted (%)**	**Risk ratio (95% CI)**	**p-value**	**n**	**Attritted (%)**	**Risk ratio (95% CI)**	**p-value**
Overall OPAT	Black	639	5.3	1.00		16	6.3	1.00	
	Gray	125	7.2	1.35 (0.67-2.75)	0.40	21	0.0	--	--
	Gold	64	4.7	0.88‡	0.99‡	39	0.0	--	--
	White	120	13.3	**2.51 (1.43-4.39)**	**<0.01**	157	10.2	1.63‡	0.99‡
SPT (cm)	Black (450)	928	6.3	1.00		38	2.6	1.00	
	Gray (400)	17	17.6	2.82‡	0.18‡	59	3.4	1.29‡	0.99‡
	Gold (350)	3	33.3	5.33‡	0.36‡	93	7.5	2.86‡	0.53‡
	White (<350)	0	0.0	--	--	43	16.3	6.19‡	0.09‡
SLJ (cm)	Black (160)	858	6.1	1.00		71	4.2	1.00	
	Gray (140)	64	12.5	2.06‡	0.10‡	71	7.0	1.67‡	0.72‡
	Gold (120)	24	8.3	1.38‡	0.88‡	69	7.2	1.72‡	0.69‡
	White (<120)	2	0.0	--	--	22	18.2	4.30‡	0.10‡
SDL (lb)	Black (≥180)	915	6.6	1.00		127	4.7	1.00	
	Gray (140)	25	4.0	0.61‡	0.99‡	78	7.7	1.63‡	0.56‡
	White (<120)	8	12.5	1.91‡	0.85‡	28	17.9	3.78‡	0.06‡
IAR (shuttles)	Black (43)	692	5.2	1.00		49	4.1	1.00	
	Gray (40)	87	8.0	1.55 (0.71-3.37)	0.27	18	0.0	--	--
	Gold (36)	53	5.7	1.09 (0.35-3.42)	0.89	23	0.0	--	--
	White (<36)	116	13.8	**2.65 (1.52-4.62)**	**<0.01**	143	10.5	2.57‡	0.28‡

Notes:
Bold: p-value for Risk Ratio ≤0.05
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift (3 categories tested: Black, Gray, and White); IAR = Interval Aerobic Run
-- Dashed lines indicates that RR and p-values were not calculated
‡At least one expected value was <5. Fisher exact test was used for p-value; unable to calculate confidence interval for risk ratio.

Table 13. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Raw Performance Bins and 10-Week Attrition among Men and Women

	Men (n=948)					Women (n=233)				
OPAT Event	**Performance Cut-points**	**n**	**Attritted (%)**	**Risk ratio (95% CI)**	**p-value**	**Quartile Cut Score**	**n**	**Attritted (%)**	**Risk ratio (95% CI)**	**p-value**
SPT (cm)	Q1: ≤538	252	6.7	0.94 (0.49-1.80)	0.85	Q1: ≤350	75	12.0	5.88 (‡)	0.09‡
	Q2: 539	242	8.7	1.21 (0.65-2.24)	0.54	Q2: 351	44	9.1	4.46 (‡)	0.30‡
	Q3: 589	217	3.2	0.45 (0.19-1.06)	0.06	Q3: 376	65	4.6	2.26 (‡)	0.84‡
	Q4: ≥645	237	7.2	1.00		Q4: ≥426	49	2.0	1.00	
SLJ (cm)	Q1: ≤178.0	238	9.2	**2.17 (1.05-4.49)[a]**	**0.03**	Q1: ≤131.50	60	11.7	6.65 (‡)	0.07‡
	Q2: 178.01	238	7.6	1.78 (0.84-3.77)[a]	0.13	Q2: 131.51	58	6.9	3.93 (‡)	0.37‡
	Q3: 198.51	237	5.1	1.19 (0.52-2.70)[a]	0.68	Q3: 145.51	58	8.6	4.91 (‡)	0.21‡
	Q4: ≥218.01	235	4.3	1.00[a]		Q4: ≥164.51	57	1.8	1.00	
SDL (lb)	≤140	33	6.1	0.98 (‡)	0.99‡	≤140	106	10.4	3.22 (‡)	0.39‡
	180	92	9.8	1.58 (0.80-3.10)	0.19	180	96	5.2	1.62 (‡)	0.99‡
	220	823	6.2	1.00		220	31	3.2	1.00	
IAR (shuttles)	Q1: ≤42	256	10.2	**3.00 (1.38-6.49)[a]**	**<0.01**	Q1: ≤23	60	20.0	**4.9 (‡)**	**0.01**
	Q2 :43	238	7.6	**2.23 (0.99-5.03)[a]**	**0.05**	Q2: 24	59	5.1	1.25(‡)	0.99‡
	Q3: 54	218	4.6	1.35 (0.54-3.37)[a]	0.51	Q3: 32	65	0.0	--	--
	Q4: ≥67	236	3.4	1.00[a]		Q4: ≥43	49	4.1	1.00	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift; IAR = Interval Aerobic Run
Bold Risk Ratio: p-value ≤0.05
-- Dashed lines indicates that RR and p-values were not calculated due to 0 counts of incidence in the comparison group.
‡ At least one expected value was <5. Fisher exact test was used for p-value; unable to calculate confidence interval for risk ratio.
[a] p<0.01for linear trend (Mantel-Haenszel Chi-square test for trend)

Table 14. Raw Occupational Physical Assessment Test (OPAT) Event Performance Stratified by 10-Week Attrition Status

	Trainee Group								
	Combined (n=1,181)			Men (n=948)			Women (n=233)		
OPAT Event	Attritted (n=79) Mean ± SD	Completed Training (n=1,102) Mean ± SD	p-value[a]	Attritted (n=62) Mean ± SD	Completed Training (n=886) Mean ± SD	p-value[a]	Attritted (n=17) Mean ± SD	Completed Training (n=216) Mean ± SD	p-value[a]
SPT (cm)	535.3 ± 111.3	553.8 ± 111.3	**0.16**	583.7 ± 81.0	593.9 ± 81.2	0.34	359.0 ± 44.8	389.6 ± 51.3	**0.02**
SLJ (cm)	178.5 ± 34.0	189.2 ± 34.9	**<0.01**	189.52± 27.8	199.0 ± 29.9	**0.02**	138.2 ± 21.9	149.1 ± 23.4	0.07
IAR	43.0 ± 19.5	51.8 ± 19.4	**<0.001**	48.6 ± 17.6	56.1 ± 18.0	**0.001**	22.6 ± 10.6	34.0 ± 14.2	**0.001**
SDL	**n (%)**	**n (%)**	**p-value[b]**	**n (%)**	**n (%)**	**p-value[b]**	**n (%)**	**n (%)**	**p-value[b]**
60 lb	1 (1.3)	2(0.2)		0 (0.0)	1 (0.1)		1 (5.9)	1 (0.5)	
100 lb	5 (6.3)	28 (2.5)		1 (1.6)	6 (0.7)		4 (23.5)	22 (10.2)	
140 lb	7 (8.9)	96 (8.7)	0.10	1 (1.6)	24 (2.7)	0.60	6 (35.3)	72 (33.3)	**0.05**
180 lb	14 (17.7)	174 (15.8)		9 (14.5)	83 (9.4)		5 (29.4)	91 (42.1)	
220 lb	52 (65.8)	802 (72.8)		51 (82.3)	772 (87.1)		1 (5.9)	30 (13.9)	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; IAR = Interval Aerobic Run; SDL = Strength Deadlift
[a] p-value, t-test comparing mean performance of trainees that attritted versus completed training (**Bold**: p-value ≤0.05)
[b] p-value, Chi-square comparing distribution of trainees that attritted versus completed training (**Bold**: p-value ≤0.05)

5.7 Association of the OPAT and Final Attrition at Completion of IET

To account for attrition that occurred beyond the first 10 weeks of IET, we tracked trainees through the end of IET (i.e., through the completion of BCT-AIT or OSUT). **Table 15** summarizes this final attrition stratified by trainee characteristics. Final attrition among men (13.7%) and women (16.3%) was not significantly different (p=0.31). Final attrition was significantly higher than the 10-week attrition (Table 10) for men (p<0.001) and women (p<0.01). For both sexes, having had an injury during the first 10 weeks of training significantly increased the final attrition risk (men: 3.0 times higher risk p<0.001; women: 2.8 times higher risk; p<0.01).

For the sexes combined, **Table 16** summarizes the association of OPAT performance and final attrition stratified by PDC (upper portion of the table) and then by raw event performance bins (lower portion of the table). When the OPAT performance was stratified by PDC for the composite OPAT, trainees in the White category had 1.8 times higher attrition risk (p<0.001) compared to trainees that met the Black PDC standard. There were significant trends for the SDL (p<0.01) and IAR (p<0.01) events such that attrition risk increased as performance decreased going from the Black PDC to the White category; however, only for the White category was the higher risk statistically significant. Trainees in the White category for the SPT, SDL, and IAR events had significantly higher attrition (2.7 (p=0.01), 2.3 (p<0.01), and 1.9 times higher (<0.001), respectively), compared to trainees that met the Black PDC standard for the event.

In the lower-portion of **Table 16,** findings are presented (sexes combined) for the association of raw performance and final attrition stratified by performance bins (sex-neutral quartiles for SPT, SLJ, and IAR events; and three categories of weight lifted for the SDL event). There were significant associations with at least one performance bin on each of the four events. The SLJ, SDL, and IAR events had significant linear trends (SLJ; p<0.001; SDL; p<0.01; and IAR; p<0.001) where the attrition risk increased with decreasing performance from the event's highest performance bin (Q4 for the SPT and IAR events; 220 lb on the SDL event) to the event's lowest performance bin (Q1 for the SPT and IAR events; ≤140 lb on the SDL event).

Considering the uneven distribution of sexes by OPAT PDC **(Table 3)**, we conducted these same analyses for the association of OPAT performance and final attrition for men and women, separately. Findings for these associations by sex are stratified by OPAT PDCs in **Table 17** and by raw performance bins in **Table 18**. Even though the final attrition was nearly two times higher than the 10-week attrition, results by sex stratified by PDCs **(Table 17)** were still limited by too few attrition cases to calculate CIs for some RRs (indicated by ‡ in the table). Similar to the 10-week attrition results stratified by PDCs **(Table 12)**, the only significant associations among men were for the composite OPAT and the IAR event **(Table 17)**. Compared to men that met the Black PDC standard, men in the White category had 1.9 times higher final attrition risk for the composite OPAT and for the IAR event (OPAT: p<0.01; IAR: p=0.001). New findings among women, unlike the 10-week attrition results, were a 4.4 times higher final attrition risk (p<0.01) for the White category on the SPT event, a 2.3 times higher final attrition risk (p=0.03) for the

Gold PDC on the SLJ event, and a 2.6 times higher final attrition risk (p=0.04) for the White category on the IAR event compared to the respective event's Black PDC.

Table 18 presents findings for the association of raw event performance and final attrition stratified by performance bins for men and women, separately. Among men, there were significant trends for the SLJ (p<0.01) and IAR (p<0.001) events such that attrition risk increased going from the highest performance bins (Q4) to the lowest (Q1). But only on the IAR event was the attrition risk significantly higher for each increasing performance bin (Q1, Q2, and Q3) compared to the highest performance bin (Q4). Among women, there were significant trends for the SLJ (p=0.01) and IAR (p<0.01) events where the attrition risk increased going from the highest performance bins (Q4) to the lowest (Q1); however, in both cases, only the lowest performance bin (Q1) had significantly higher attrition risk compared to the event's highest performance bin (Q4).

Lastly, we compared the raw OPAT event performance between trainees that attritted and those that completed training **(Table 19)**. In the analysis with sexes combined, trainees that eventually attritted performed at a significantly lower level on all four events (p<0.01 to p<0.001, by event). But on further evaluation with the ANOVA, there was a main effect of sex on performance on all four events (ANOVA: p<0.001 for each event), with no interaction effect between sex and attrition. To account for this effect of sex, we performed the same comparisons within each sex. Among men, those that attritted performed at a significantly lower level on all four events (p=0.04 to p<0.001). Relative to men that completed IET, these differences were 15.7 cm shorter (-26.4%) throw on the SPT, 8.7 cm (-4.4%) shorter jump on the SLJ, 8 fewer IAR shuttles (-14.1%), and 8.8% fewer injured men were able to lift the heaviest weight (220 lb) on the SDL. Among the women, trainees that attritted performed at a lower mean level on the SPT, SLJ, and IAR events. Relative to women that completed IET, these differences were 27.7 cm shorter (-7.1%) throw on the SPT, 9.6 cm shorter (-6.4% shorter) jump on the SLJ, and 8 fewer (-22.1%) IAR shuttles.

Table 15. Final Attrition Incidence and Association with Trainee Characteristics

	Trainee Groups											
	Combined (n=1,181)				Men (n=948)				Women (n=233)			
Characteristic	**n**	**Attritted (%)**	**Risk Ratio (95% CI)**	**p-value**	**n**	**Attritted (%)**	**Risk Ratio (95% CI)**	**p-value**	**n**	**Attritted (%)**	**Risk Ratio (95% CI)**	**p-value**
Sex												
Overal/	1,181	14.2										
Men	948	13.7			948	13.7						
Women	233	16.3	1.19 (0.85-1.66)	0.31					233	16.3		
Age (years)												
<20	547	14.4	1.00		424	13.7	1.00		123	17.1	1.42 (0.46-4.41)	0.53
20-24	499	13.6	0.94 (0.70-1.27)	0.70	414	13.0	0.95 (0.68-1.35)	0.79	85	16.5	1.37 (0.43-4.40)	0.59
≥25	132	15.2	1.05 (0.67-1.65)	0.84	107	15.9	1.16 (0.71-1.91)	0.56	25	12.0	1.00	
Training Type												
BCT-AIT	502	14.1	0.99 (0.75-1.32)	0.94	313	11.8	1.00		189	18.0	1.98 (0.74-5.29)	0.15
OSUT	679	14.3	1.00		635	14.6	1.24 (0.87-1.77)	0.24	44	9.1	1.00	
Injured[a]												
No	774	8.5	1.00		651	8.4	1.00		123	8.9	1.00	
Yes	407	25.1	**2.94 (2.21-3.91)**	**<0.001**	297	25.3	**2.99 (2.17-4.11)**	**<0.001**	110	24.5	**2.75 (1.43-5.27)**	**<0.01**

Notes:
Bold: p-value for Risk Ratio ≤0.05
[a] Injured during the first 10 weeks of IET

Table 16. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Physical Demand Category (PDC) and Raw Performance Bins with Final Attrition, Sexes Combined

OPAT Event	PDC Cut-point or Performance Cut-points	Combined (n=1,181) n	Attritted (%)	Risk ratio (95% CI)	p-value
Overall OPAT	Black	655	11.6	1.00	
	Gray	146	14.4	1.24 (0.79-1.94)	0.35
	Gold	103	12.6	1.09 (0.63-1.89)	0.77
	White	277	20.9	**1.81 (1.32-2.46)**	**<0.001**
SPT (cm)	Black (450)	966	13.1	1.00	
	Gray (400)	76	13.2	1.00 (0.55-1.82)	1.0
	Gold (350)	94	16.7	1.27 (0.79-2.04)	0.33
	White (<350)	43	34.9	**2.65 (1.71-4.12)**	**<0.001**
SLJ (cm)	Black (160)	929	13.0	1.00	
	Gray (140)	135	16.3	1.25 (0.82-1.90)	0.30
	Gold (120)	93	21.5	**1.65 (1.08-2.52)**	**0.02**
	White (<120)	24	20.8	1.60 (0.72-3.55)	0.27
SDL (lb)	Black (180)	1042	13.5	1.00[a]	
	Gray (140)	103	15.5	1.15 (0.71-1.85)[a]	0.57
	White (<120)	36	30.6	**2.26 (1.35-3.78)[a]**	**<0.01**
IAR (shuttles)	Black (43)	741	11.3	1.00[a]	
	Gray (40)	105	15.2	1.34 (0.82-2.20)[a]	0.25
	Gold (36)	76	15.8	1.39 (0.80-2.43)[a]	0.25
	White (<36)	259	21.6	**1.91 (1.40-2.59)[a]**	**<0.001**
SPT (cm)	Q1: ≤488	313	15.7	1.43 (0.93-2.19)	0.10
	Q2: 489	278	18.0	**1.63 (1.08-2.50)**	**0.02**
	Q3: 564	316	12.3	1.13 (0.72-1.76)	0.60
	Q4: ≥626	274	10.9	1.00	
SLJ (cm)	Q1: ≤164.00	300	18.7	**2.11 (1.36-3.27)[a]**	**<0.001**
	Q2: 164.01	299	16.1	**1.82 (1.16-2.85)[a]**	**<0.01**
	Q3: 190.51	288	13.2	1.49 (0.93-2.39)[a]	0.09
	Q4: ≥212.51	294	8.8	1.00[a]	
SDL (lb)	≤140	139	19.4	**1.55 (1.06-2.27)[a]**	**0.03**
	180	188	18.1	**1.44 (1.02-2.05)[a]**	**0.04**
	220	854	12.5	1.00[a]	
IAR (shuttles)	Q1: ≤38	309	20.1	**2.52 (1.61-3.96)[a]**	**<0.001**
	Q2: 39	295	15.6	**1.96 (1.22-3.15)[a]**	**<0.01**
	Q3: 51	288	12.8	**1.61 (0.98-2.65)[a]**	**0.05**
	Q4: ≥64	289	8.0	1.00 [a]	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift (3 categories tested: Black, Gray, and White); IAR = Interval Aerobic Run
Bold: p-value for Risk Ratio ≤0.05
[a] p<0.01 for linear trend (Mantel-Haenszel Chi-square test for trend)

Table 17. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Physical Demand Category (PDC) and Final Attrition, Men and Women

		Men (n=948)				Women (n=233)			
OPAT Event	**PDC Cut-points**	**n**	**Attritted (%)**	**Risk ratio (95% CI)**	**p-value**	**n**	**Attritted (%)**	**Risk ratio (95% CI)**	**p-value**
Overall OPAT	Black	639	11.7	1.00		16	6.3	1.00	
	Gray	125	16.0	1.36 (0.87-2.15)	0.19	21	4.8	0.76‡	0.99‡
	Gold	64	14.1	1.20 ().63-2.28)	0.58	39	10.3	1.64‡	0.99‡
	White	120	21.7	**1.85 (1.24-2.76)**	**<0.01**	157	20.4	3.26‡	0.30‡
SPT (cm)	Black (450)	928	13.4	1.00‡		38	7.9	1.00	
	Gray (400)	17	29.4	2.2‡	0.14‡	59	8.5	1.1‡	0.99†
	Gold (350)	3	33.3	2.50‡	0.70‡	93	16.1	2.04 (0.63-6.65)	0.21‡
	White (<350)	0	0.00	--	--	43	34.9	**4.42 (1.39-14.10)**	**<0.01**
SLJ (cm)	Black (160)	858	13.2	1.00		71	11.3	1.00	
	Gray (140)	64	20.3	1.54 (0.92-2.58)	0.16‡	71	12.7	1.13‡	0.99‡
	Gold (120)	24	16.7	1.27‡	0.79‡	69	23.2	**2.25 (1.05-4.84)**	**0.03**
	White (<120)	2	0.0	--	--	22	22.7	2.02‡	0.31‡
SDL (lb)	Black (180)	915	13.6	1.00‡		127	13.4	1.00	
	Gray (140)	25	12.0	0.89‡	>0.99‡	78	16.7	1.25 (0.64-2.42)	0.66†
	White (<120)	8	37.5	2.77‡	0.17‡	28	28.6	2.13‡	0.10‡
IAR (shuttles)	Black (43)	692	11.6	1.00		49	8.2	1.00‡	
	Gray (40)	87	17.2	1.49 (0.90-2.47)	0.13	18	5.6	0.68‡	0.99‡
	Gold (36)	53	17.0	1.47 (0.78-2.76)	0.24	23	13.0	1.60‡	0.79‡
	White (<36)	116	22.4	**1.94 (1.30-2.88)**	**<0.001**	143	21.0	**2.57 (0.96-6.93)**	**0.04**

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift (3 categories tested: Black, Gray, and White); IAR = Interval Aerobic Run
Bold: p-value for Risk Ratio ≤0.05
‡ At least one expected value was <5. Fisher exact test was used for p-value; unable to calculate confidence interval for risk ratio.

Table 18. Association of Occupational Physical Assessment Test (OPAT) Performance Stratified by Raw Performance Bins and Final Attrition among Men and Women

OPAT Event	Men (n=948)					Women (n=233)				
	Performance Cut-points	**n**	**Attritted (%)**	**Risk ratio (95% CI)**	**p-value**	**Performance Cut-points**	**n**	**Attritted (%)**	**Risk ratio (95% CI)**	**p-value**
SPT (cm)	Q1: ≤538	252	16.3	1.43 (0.91-2.25)	0.12	350	75	24.0	**2.35 (0.93-5.92)**	**0.05**
	Q2: 5.39	242	16.1	1.42 (0.90-2.23)	0.13	373	44	20.5	2.01 (0.73-5.53)	0.17
	Q3: 589	217	10.6	0.93 (0.55-1.57)	0.79	425	65	9.2	0.90†	0.99‡
	Q4: ≥645	237	11.4	1.00		426	49	10.2	1.00	
SLJ (cm)	Q1: ≤178.0	238	18.5	**1.98 (1.22-3.19)[a]**	**<0.01**	131.5	60	25.0	**3.56 (1.26-10.10)[a]**	**<0.01**
	Q2: 178.01	238	14.7	1.57 (0.95-2.60)[a]	0.07	145.5	58	17.2	2.46 (0.82-7.38)[a]	0.09
	Q3: 198.51	237	12.2	1.31 (0.77-2.21)[a]	0.32	164.5	58	15.5	2.21 (0.72-6.77)[a]	0.15
	Q4: ≥218.01	235	9.4	1.00[a]		164.5	57	7.0	1.00[a]	
SDL (lb)	≤140	33	18.2	1.45†	0.47†	≤140	106	19.8	1.54 (0.57-4.14)	0.38
	180	92	22.8	**1.82 (1.20-2.77)**	**<0.01**	180	96	13.5	1.05‡	0.99‡
	220	823	12.5	1.00		220	31	12.9	1.00	
IAR (shuttles)	Q1: ≤42	256	19.5	**3.29 (1.87-5.80)**[a]	**<0.001**	23	60	30.0	**3.68 (1.33-10.15)[a]**	**<0.01**
	Q2: 43	238	17.2	**2.90 (1.62-5.18)[a]**	**<0.001**	31	59	13.6	1.66 (0.53-5.19)[a]	0.37
	Q3: 54	218	11.5	**1.93 (1.03-3.62)[a]**	**0.04**	42	65	12.3	1.51 (0.48-4.72)[a]	0.48
	Q4: ≥67	236	5.9	1.00[a]		43	49	8.2	1.00[a]	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; SDL = Strength Deadlift; IAR = Interval Aerobic Run
Bold: p-value for Risk Ratio ≤0.05
‡ At least one expected value was <5. Fisher exact test was used for p-value; unable to calculate confidence interval for risk ratio.
[a] p<0.01 for linear trend (Mantel-Haenszel Chi-square test for trend)

Table 19. Raw Occupational Physical Assessment Test (OPAT) Event Performance Stratified by Final Attrition Status

	Trainee Groups								
	Combined (n=1,181)			Men (n=948)			Women (n=233)		
OPAT Event	**Attritted (n=168) Mean ± SD**	**Completed Training (n=1,013) Mean ± SD**	**p-value[a]**	**Attritted (n=130) Mean ± SD**	**Completed Training (n=818) Mean ± SD**	**p-value[a]**	**Attritted (n=38) Mean ± SD**	**Completed Training (n=195) Mean ± SD**	**p-value[a]**
SPT (cm)	531.1 ± 115.6	556.2 ± 110.9	**<0.01**	579.7 ± 78.1	595.4 ± 81.5	**0.04**	364.7 ± 47.5	391.8 ± 51.1	**<0.01**
SLJ (cm)	179.5 ± 33.7	190.0 ± 34.9	**<0.001**	190.9 ± 27.5	199.6 ± 30.1	**<0.01**	140.3 ± 21.6	149.9 ± 23.6	**0.02**
IAR (shuttles)	43.8 ± 18.0	52.4 ± 19.5	**<0.001**	48.7 ± 16.5	56.7 ± 18.0	**<0.001**	26.8 ± 11.6	34.4 ± 14.4	**<0.01**
SDL	**n (%)**	**n (%)**	**p-value[b]**	**n (%)**	**n (%)**	**p-value[b]**	**n (%)**	**n (%)**	**p-value[b]**
60 lb	2 (1.2)	1 (0.1)		1 (0.8)	0 (0)		1 (2.6)	1 (0.5)	
100 lb	9 (5.4)	24 (2.4)		2 (1.5)	5 (0.6)		7 (18.4)	19 (9.7)	
140 lb	16 (9.5)	87 (8.6)	**<0.01**	3 (2.3)	22 (2.7)	**<0.01**	13 (34.2)	65 (33.3)	0.33
180 lb	34 (20.2)†	154 (15.2)		21 (16.2)†	71 (8.7)		13 (34.2)	83 (42.6)	
220 lb	107 (63.7)	747 (73.7)†		103 (79.2)	720 (88.0)†		4 (10.5)	27 (13.8)	

Notes:
SPT = Seated Power Throw; SLJ = Standing Long Jump; IAR = Interval Aerobic Run; SDL = Strength Deadlift
[a] p-value, t-test comparing mean performance of trainees that attritted versus completed training (**Bold**: p-value ≤0.05)
[b] p-value, Chi-square comparing distribution of trainees that attritted versus completed training men and women (**Bold**: p-value ≤0.05)
† p-value <0.05 for difference between proportions of trainees that attritted versus completed training

6 DISCUSSION

6.1 Major Findings

The OPAT is a physical performance test designed to screen Army recruits for meeting the physical requirements associated with an MOS. The OPAT Longitudinal Validation Study was conducted in 2016, before the OPAT became an enlistment requirement for all new accessions in January 2017. The primary objective of that study was to validate the OPAT among recruits during their IET, but the study also afforded the opportunity to evaluate, prospectively, the relationships between OPAT performance at the beginning of IET and the incidence of injuries and attrition during IET. Accordingly, this report represents the first documentation of the association between physical performance on the OPAT and incidence of injuries and attrition during IET. The major findings of this report demonstrate that—

- Among sexes combined and men alone (but not women), achievement on the composite (4-event) OPAT was inversely associated with injury risk during the first 10 weeks of IET. Trainees in the Gray PDC (combined sexes: $p=0.02$; men: $p=0.02$) and White category (combined sexes: $p<0.01$; men: $p<0.01$) had significantly higher injury risk compared to trainees that met the OPAT standard for the Black PDC.

- Among sexes combined, there were significant inverse trends for injury on the SLJ and SDL events such that injury risks increased as event performance decreased going from the Black PDC to the White category (SLJ: $p<0.001$; SDL: $p<0.001$). Among men and women, separately, only the IAR event was associated with injury risk. Among men, injury risk was significantly higher for trainees in the IAR Gray PDC ($p=0.02$) and White category ($p<0.01$) compared to men in the Black PDC. Among women, injury risk was significantly higher for women in the IAR White category ($p=0.02$) compared to women in the Black PDC.

- Among sexes combined and men alone (but not women), achievement on the composite OPAT was inversely associated with final IET attrition. Trainees in the lowest performing White category had significantly higher final attrition compared to trainees that met the standard for the Black PDC (sexes combined: $p<0.001$; men: $p<0.01$).

- Among sexes combined, there were significant inverse trends for attrition on the SDL ($p<0.001$) and IAR ($p<0.001$) events such that final attrition risk increased as event performance decreased going from the event's Black PDC to the White category. Among men and women separately, men in the White category for the IAR event ($p<0.01$) and women in the White category for the SPT ($p<0.01$) and IAR ($p=0.04$) events had significantly higher attrition compared to trainees in the respective Black PDC within sex.

- Similar to previous findings of significant relationships between decreased aerobic fitness (e.g., increased 2-mile run time) and increased injury risk, we observed that a lower number of IAR shuttles (an indicator of lower aerobic fitness) on the OPAT was also associated with elevated injury risk among men and women, separately and combined.

- Field-expedient muscular strength and power tests offered by the OPAT provided new insight into the relationship of these fitness components with injury and attrition risk among trainees.

6.2 OPAT Performance by PDC at Start of IET

On the composite (4-event) OPAT, just over half of all trainees (sexes combined; 55.5%) achieved the highest standard (Black PDC; 'Heavy' physical demands) established by TRADOC. If the current standards had been in effect when the study participants enlisted, trainees that achieved the Black PDC would have qualified to enlist in a Combat Arms MOS or other MOS with a 'Heavy' physical demand rating (DA 2016a). Twelve percent of the trainees met the standard for the Gray PDC ('Significant' physical demands) and 8.7% met the standard for the lowest-acceptable PDC to begin military training (Gold: 'Moderate physical demands). Interestingly, approximately one-quarter of the trainees (23.5%; White category ('currently unqualified') did not meet the lowest acceptable standard (Gold PDC) on one or more of the OPAT events. When these trainees were recruited, there was no enlistment requirement to take or pass a physical assessment in order to enlist. Since January 2017, all new recruits are required to take the OPAT and meet at least the Gold PDC standard to enlist. Recruits that do not meet at least the Gold standard (i.e., White category, "currently unqualifited") are not able to enlist and start training but can retake the OPAT at a later date in order to meet the enlistment standard (i.e., PDC) paired to their MOS. Now, with full implementation of the OPAT, we would no longer expect to see trainees at the White category level of fitness in IET.

There were significant performance differences between the sexes on each of the OPAT events. These differences were evident when we reported performance by event PDCs (Table 3) and by raw event performance (Table 4). We expected these differences given the physiologic differences between the sexes (Epstein et al. 2015, Nindl 2015) and the well-documented differences between the sexes on common military measures of physical fitness and performance (Anderson et al. 2017, Knapik, Sharp et al. 2001). In this report, we presented findings for the associations of OPAT performance with IET injuries and attrition with the sexes combined and separated. It was important that we report these findings with the sexes combined since the intent of the OPAT is to assess the physical capability of all recruits with a single sex-neutral set of standards. But with the sex differences in OPAT performance, it was also important that we evaluate and report the findings for the sexes separately.

6.3 Injuries during IET

We prospectively identified injuries that occurred during the first 10 weeks of IET using the electronic medical records. During this phase of IET, training and injury risk exposures were similar for all enrolled trainees, whether training in BCT-AIT- or OSUT-associated MOSs. Among men, injury incidence was higher among OSUT trainees (37.2%) than BCT-AIT trainees (19.5%; $p<0.01$). The 10-week injury incidence was 31.5 and 47.2% for men and women, respectively ($p<0.001$). The sex difference in injury risk has been consistently reported in studies of IET (Jones and Knapik 1999, Knapik, Sharp et al. 2001). For both sexes, the injury

incidence was within the ranges previously reported for BCT (men: 14 to 31%; women: 36 to 67%) and OSUT (men: 30 to 46%; women: 57 to 67%), with incidence among women being approximately two times higher than among men (Jones, Cowan et al. 1993, Snoddy and Henderson 1994, USAPHC (Prov) 2008, Knapik et al. 2013a, b, APHC 2017). The higher injury risk among women is related to physiologic-mediated differences between the sexes that include lower fat-free mass, lower absolute muscular power and strength, lower bone mineral density among women (Epstein et al. 2015, Nindl 2015). Women also have a lower absolute aerobic capacity (Knapik, Sharp et al. 2001) such that they must work at a higher percentage of their maximal work capacity compared to men to perform physically strenuous tasks. Collectively, these factors are thought to place greater physiologic strain on the musculoskeletal system, predisposing women to increased injury risk (Epstein et al. 2015, Nindl 2015, Knapik, Sharp et al. 2001).

6.4 Association of OPAT Performance and IET Injuries Stratified by OPAT PDCs

This is the first prospective evaluation confirming a relationship of OPAT performance at the beginning of IET with eventual injuries during IET. Low composite OPAT performance was associated with higher injury risk among the sexes combined and men separately but not among women (Tables 6 and 7). For the sexes combined, each of the four events had a significant association with injuries for at least one of the lower performing PDCs (Gray, Gold, or White) compared to the highest performing (Black PDC). The SLJ and SDL events had the strongest associations with injury with significant inverse trends for higher injury risk as the event performance decreased going from the Black PDC to the White category. However, in these analyses with the sexes combined, the significantly different distributions of men and women by PDC (Table 3) influenced the findings. For each event, there were more women in the White category and more men in the Black PDC. Injury incidence was also significantly different between the sexes (Table 5). These factors necessitated that we evaluate the association of OPAT performance and injury among men and women, separately. In these subsequent analyses, we found a significant association of performance by PDC and injury only on the IAR event. Among men, trainees in the Gray ($p<0.01$), Gold ($p=0.03$), and White ($p<0.01$) categories had higher injury risk compared to trainees in the highest performance (Black) PDC. Among women, trainees in the White category had 1.5 times higher injury risk compared to trainees in the Black PDC ($p=0.02$).

6.5 Association of Physical Fitness Assessed by OPAT Events and IET Injuries

Many prior studies have evaluated entry-level physical fitness of trainees and the relationship with injury risks in IET. However, this was the first study that evaluated this association for the SPT, SLJ, SDL, and IAR events as measures of entry-level physical fitness among trainees via the OPAT. The SPT and SLJ events assess muscular power (upper- and lower-body power, respectively), the SDL event tests lower-body muscular strength, and the IAR event assesses aerobic fitness (Leger et al. 1988, Foulis et al. 2017, Canino et al. 2018, USARIEM 2018). To further evaluate the relationships between these fitness components (as measured by the OPAT events) and injury we used the trainees' raw performance on the OPAT events. Findings

from these analyses support and expand upon associations between injury risks stratified by the OPAT PDCs.

- Men and women combined: When OPAT performance was evaluated by the raw event performance bins (quartiles for SPT, SLJ, and IAR events; three weight categories for the SDL event), there were significant trends for higher injury incidence with lower event performance on the upper-body muscular power (SPT) event, muscular strength (SDL) event, and aerobic fitness (IAR) event (lower-portion, **Table 6;** $p<0.01$ on each event). We also found that eventually injured trainees performed at a lower level compared to uninjured trainees on both muscular power events (SPT and SLJ; $p<0.001$), the lower-body muscular strength event (SDL; $p<0.05$), and the aerobic fitness event (IAR; $p<0.001$**;** T**able 9)**.

- Men: When the OPAT-injury association was evaluated using the raw event performance bins, there were significant associations with injury on the muscular strength (SDL: 180 lb versus 220 lb; $p=0.01$) and aerobic fitness (IAR: Q1 versus Q4; $p<0.01$) events for men **(Table 8)**, but there were no significant trends as described for the sexes combined. Similarly, when we compared raw event performance between injured and uninjured men, injured men performed at a lower level on the muscular strength (SDL) and aerobic fitness (IAR) events **(Table 9)**; a smaller proportion of injured men was able to lift the heaviest SDL weight tested ($p<0.05$) and injured men completed a lower mean number of IAR shuttles ($p<0.01$) compared to uninjured men.

- Women: When OPAT event performance was stratified by raw performance bins, female trainees in the 180-lb ($p=0.02$) and ≤140-lb ($p=0.01$) bins on the lower-body muscular strength event (SDL) and the lowest performance bin (Q1) on the aerobic fitness event (IAR; $p<0.01$) had significantly higher injury risks compared to the within event highest performance bin **(Table 8).** Further supporting the association between performance on the aerobic fitness event (IAR) and injury risk, injured women performed at a significantly lower level (lower mean number of shuttles; $p<0.01$) on the IAR event compared to uninjured women **(Table 9)**.

These findings provide important insights about the relationships between injuries and the physical fitness components assessed by the OPAT events. Of the various components of physical fitness, aerobic fitness has been the most studied in IET, and the most strongly and consistently associated component of physical fitness with injuries among both sexes. The association of injury and aerobic fitness has been examined using the 1- and 2-mile run events, a 5-minute step test, and maximum oxygen uptake treadmill tests [VO_{2max}] (Jones, Bovee et al. 1993, Snoddy and Henderson 1994, Gilchrist et al. 2000, Knapik, Sharp et al. 2001, Bedno et al. 2013, Jones and Hauschild 2015, Sefton, Lohse, and McAdam 2016, de la Motte et al. 2017, Lisman et al. 2017), but to our knowledge, this association has never been evaluated using the IAR event which is also positively and strongly related to VO_{2max} (Canino et al. 2018). Our findings for a significant association between lower IAR performance and higher injury risk among men and women, separately and combined, are consistent with findings from previous studies of aerobic fitness events and injury risk. One such study that used the 2-mile run (2MR) event at the beginning of BCT found that injury risk was increased for successively slower (i.e.,

longer) quartiles of 2MR time (Knapik, Sharp et al. 2001). The slowest quartile (longest 2MR time) of men had a 1.6 times higher risk of injury than the fastest quartile (shortest 2MR time; p=0.04) of men. Similarly, the slowest quartile of women had a 1.9 times higher risk of injury compared to the fastest quartile (p<0.01)). Among men and women, injury risks increased for successively slower quartiles of 2MR time (fastest to slowest). In another study, Bedno et al., administered a modified Harvard step test (5 minutes, 120-steps per minute, with a 16-inch step) to male trainees processing through one of the Military Entrance Processing Stations (n=8,456) prior to shipping to a training installation to begin IET (Bedno et al. 2013). Passing criteria for the test was defined as completing the 5-minute test. Injuries during the first 90 days of IET were identified from electronic medical records. Trainees that failed the fitness test were 31% more likely to experience an injury in IET (adjusted hazard ratio: 1.31 (1.20 – 1.43)).

It makes sense that measures of weight bearing aerobic fitness (i.e., IAR, 1- and 2- mile run time, step test, or treadmill VO_{2max}) would be associated with injuries in IET where a majority of the training-related activity involves strenuous weight bearing activities (e.g., walking, marching, running, and road marching). Simpson et al., found that approximately 60% of training time in BCT involved weight-bearing activities (such as running, marching, and standing) and 15% of the training time involved moderate-vigorous physical activity (Simpson et al. 2013). When performing the same strenuous physical activities, the most fit individuals are able to perform at a lower percentage of their maximal aerobic capacity enabling them to perform the activities for a longer time, fatigue less rapidly, recover faster, and have a greater reserve capacity for subsequent tasks (Knapik 2015).

Far fewer studies have evaluated the associations of muscular strength and power with injury in military populations (Blacker et al. 2008, Cowan et al. 1988, Knapik, Sharp et al. 2001, de la Motte et al. 2017). Knapik et al. evaluated the prospective association of muscle strength and muscular power with IET injuries. At the beginning of IET, trainees were administered three tests for static muscle strength (upper-body, lower-body, and upright pull), one test for dynamic muscle strength (incremental dynamic lift), and one test for leg power (vertical jump) (Knapik, Sharp et al. 2001). None of the muscular strength or power tests were associated with injury among men or women. To the contrary, a study of British Army recruits found that on three muscular strength tests (i.e., static lift test, back extension, and dynamic lift) recruits (men and women combined) in the lowest performance quintile had significantly higher injury risk compared to the second lowest quintile (Blacker et al. 2008). Overall, considering the results of the current study and findings from previous studies, there appear to be associations of injury risk with muscle strength and muscular power, but these associations are weaker and less consistent than the associations between injuries and aerobic fitness (de la Motte et al. 2017, Jones and Hauschild 2015). Hauschild et al., evaluated the correlations between common military occupational tasks and fitness tests that assess aerobic fitness, muscle strength, muscular endurance, and flexibility (Hauschild et al. 2017). The strongest correlations were between tests of aerobic fitness and the military tasks. Though the upper- and lower-body strength tests were correlated with some of the tasks, their correlations were not as strong as assessments of aerobic fitness. This finding may help explain why muscular strength and power are not as strongly associated with injuries in the military training environment as is aerobic fitness. This is an area that requires further investigation to better understand if, when, and how

muscular strength and power influence injuries in the IET environment, and how military leaders can leverage this information to possibly prevent injuries through training targeted at improving these physical attributes.

6.6 Attrition during IET

We examined IET attrition (discharge from the Army) in two timeframes: the first 10 weeks of IET (10-week attrition: same timeframe as the injury analysis) and the entire duration of IET (final attrition: completion of BCT-AIT or OSUT). The 10-week attrition for sexes combined was 6.7%. Male and female trainees that had an injury during IET had 2.5 and 5.2 times higher attrition, respectively, compared to uninjured same sex trainees. By the end of BCT-AIT and OSUT, attrition had more than doubled (14.2%). For both attrition timeframes, having one or more injuries during the first 10 weeks of IET was a significant risk factor for attrition among both sexes. By end of IET, attrition risk was 3.0 times higher for injured men ($p<0.001$) and 2.8 times higher for injured women ($p<0.01$) relative to uninjured trainees within the same sex.

There are very few studies of attrition during IET. From a BCT study in 1998, Knapik et al. reported that 13% and 23% of men and women, respectively, were discharged during the 10-week BCT course (Knapik, Canham-Chervak, Hauret et al. 2001). This was much higher than the 10-week attrition in our current study (men: 6.5%; women: 7.3%). Previous reports of attrition among men in OSUT ranged from 5.7 to 8.0% for men in the Engineer and Military Police OSUTs at Fort Leonard Wood, Missouri (Knapik et al. 2013a, b). In our current study, attrition was much higher among OSUT men (14.3%), but our study included men in the OSUTs that train at Fort Benning, GA (i.e., Infantry, Armor, and Cavalry). The only previous study that reported attrition among OSUT women included only the Military Police OSUT at Fort Leonard, MO (attrition: 16.3%) (Knapik et al. 2013b). The slightly lower attrition that we report currently for OSUT women (14.3%) included women in the Engineer and Military Police OSUTs at Fort Leonard Wood.

Our finding that injury was a significant risk factor for IET attrition is supported by previous studies with similar findings (Hauret, Shippey, and Knapik 2001, Knapik, Canham-Chervak, Hauret et al. 2001, USACHPPM 2004a, Wills et al. 2004, Swedler et al. 2011). Swedler et al., found that injured men and women in BCT were 3.5 and 4.0 times more likely, respectively, to be discharged compared to uninjured trainees within the same sex (Swedler et al. 2011). Hauret et al., reported that up to 57% of trainees with serious injuries that limited training for more than 7 days were ultimately discharged from BCT (Hauret, Shippey, and Knapik 2001). Among British Army trainees (sexes combined), trainees treated for anterior knee pain (i.e., a common overuse injury during IET) had a 2.5 (95% CI: 2.3-17.7) times higher discharge rate relative to uninjured trainees (Wills et al. 2004).

6.7 Association of the OPAT Performance and Final Attrition Stratified by PDCs

For trainees in the lowest performing White category (relative to those in the highest performing Black PDC), we found that the composite OPAT was associated with higher final attrition among the sexes combined and men separately (combined sexes: $p<0.001$; men: $p<0.01$). Considering

the individual OPAT events, there were significant trends for the sexes combined on the SDL ($p<0.01$) and IAR ($p<0.01$) events such that attrition risk increased as performance decreased going from the Black PDC to the White category. The SPT and SLJ events were also associated with final attrition but only for the SPT event's White versus Black categoy comparison ($p<0.001$) and the SLJ event's Gold versus Black PDC comparison ($p=0.02$).

In combined sex analyses for the association of OPAT performance by PDC and final attrition, the significantly different distributions of performance by sex on the composite OPAT and each of the events influenced the results. As presented in **Table 3**, the performance distribution of men was biased toward the higher performance PDCs; whereas among women, the performance distribution was biased toward the lower performance PDCs. This necessitated that we further investigate the association of OPAT-event performance by PDC and final attrition for the sexes separately. But these within sex analyses were also affected, more so among women, by the skewed performance distributions within sex and lower attrition incidence in the higher performance PDCs. As a result, among men, only the IAR event was significantly associated with higher final attrition risk but only for the White versus Black PDC comparison ($p<0.001$). Among women, the SPT, SLJ, and IAR events were associated with final attrition, but only for the White versus Black PDC comparisons on the SPT ($p<0.001$) and IAR: $p=0.04$) events and only for the Gold versus Black PDC comparison for the SLJ event ($p=0.03$).

6.8 Association of Physical Fitness Assessed by OPAT Events and Final Attrition

Only a few prior studies examined entry-level physical fitness among trainees as it relates to attrition risk, but none of them evaluated this association with the SPT, SLJ, SDL, and IAR events as measures of upper- and lower-body muscular power, lower-body muscular strength, and aerobic fitness, respectively. We evaluated the association of event performance and attrition using raw event performance bin (quartiles of performance on the SPT, SLJ, and IAR events; 3 categories or weight lifted on the SDL event).

- Among sexes combined, there were significant inverse trends on the lower-body muscular power event (SLJ), lower-body muscular strength event (SDL), and the aerobic fitness event (IAR) such that final attrition risk increased as performance decreased from the highest performance bin to the lowest performance bin ($p<0.01$ on each event) **(Table 16)**. Supplementing these findings, we found that trainees that attritted performed at a significantly lower level on each of the four events compared to trainees that completed IET **(Table 19)**.

- Among men, there were significant inverse trends on the lower-body muscular power event (SLJ; $p<0.01$) and the aerobic fitness event (IAR; $p<0.01$) such that attrition risk increased as performance decreased from the highest performance bin to the lowest bin **(Table 18)**. In further investigations, we found that men who attritted performed at a lower level on each of the events compared to men who completed training **(Table 19)**.

- Among women, there were significant inverse trends on the lower-body muscular power (SLJ; $p<>0.01$) and aerobic fitness (IAR; $p<0.01$) events where attrition risk increased as performance decreased from the highest performance bin to the lowest **(Table 18)**. We also

found that women who attritted performed at a significantly lower level on the upper- and lower-body muscular power events (SPT and SLJ) and on the aerobic fitness event (IAR) compared to women who completed training **(Table 19)**.

Prior investigations support the current findings of higher attrition with lower aerobic fitness, but this is the first study that examined this association with the IAR event. To our knowledge, no studies evaluated the relationship between attrition and measures of muscular power or strength. Most previous IET attrition studies relied on the three events that comprise the APFT. These events measured muscular endurance (2-minute push-up and 2-minute sit-up events) and aerobic fitness (1- or 2- mile run for time). Two studies that examined these fitness factors/ events reported higher levels of attrition with lower levels of muscular endurance and aerobic fitness at the beginning of IET (Snoddy and Henderson 1994, Knapik, Canham-Chervak, Hauret et al. 2001, USACHPPM 2004a, Swedler et al. 2011). Knapik et al., found a dose-response relationship for both sexes such that progressively lower quartiles of muscular endurance or aerobic fitness had progressively higher attrition risk. Men and women in the lowest performance quartile on any of the APFT events were 1.9 to 3.3 times more likely to be discharged compared to same-sex peers in the highest performing quartiles (Knapik, Canham-Chervak, Hauret et al. 2001, USACHPPM 2004a). In another study, Snoddy et al., examined attrition among male trainees in the 13-week Infantry OSUT course; they reported that the lowest performing men on any of the APFT events had 4.1 to 8.0 times higher attrition than the highest performing men (Snoddy and Henderson 1994). The Assessment of Recruit Motivation and Strength (ARMS) Study investigated the association of attrition with a muscular endurance event (1-minute push-up test) and an additional aerobic fitness event (5-minute step test) (Niebuhr et al. 2008). Performance on these fitness measures were inversely associated with attrition during the first 180 days of military service. Taken together with findings from the current study, there is some evidence supporting the associations of final attrition with the upper- and lower-body muscular power events (SPT and SLJ), muscular strength event (SDL), aerobic fitness events (IAR, 2MR, 5-minute step test), and muscular endurance events (push-up and sit-up events). The strongest and most consistent findings involved the aerobic fitness tests. Further investigations are needed to confirm findings for muscular power, strength, and endurance events, and their relationships with attrition.

Most of the previous studies did not speculate about possible mechanisms for the association between physical fitness and attrition. The exception was the ARMS study in which the investigators attributed some of the observed effect to the motivation of the test subjects to succeed when performing the fitness events. It would be easy to suggest that trainees with low aerobic fitness or muscular power, strength, or endurance are unable to meet the graduation standards on the APFT and are consequently discharged for APFT failure. However, findings from IET attrition surveillance conducted by the APHC indicate this is not the case. The number and percent of trainees discharged for APFT failure are extremely small. More probable hypotheses to explain the relationship between attrition and components of physical fitness are:

- Trainees with lower levels of physical fitness may be more physically challenged with the rigors of IET compared to more fit trainees. They may be more likely to become discouraged and possibly lose their motivation to continue training, resulting in discharge.

- Studies have identified a variety of psycho-social factors that affect performance on fitness tests among other age groups and populations (Biddle, Goudas, and Page 1994, Goudas, Biddle, and Fox 1994, Standage, Duda, and Ntoumanis 2003, Moreno et al. 2010). Some of these factors are: (1) task orientation (i.e., establishing superiority over performance of other), (2) ego orientation (i.e., focus on personal performance and improvement), and (3) perceived competence on the tasks. It is likely that these same factors would influence a trainee's level of motivation, effort, and performance on the OPAT events or on the first iteration of the APFT in IET. These factors have also been found to influence final outcomes in IET (i.e., graduation or discharge) (Booth-Kewley, Larson, and Ryan 2002, McCraw and Bearden 1990, Niebuhr et al. 2008).

- There is evidence from prior studies (de la Motte et al. 2017, Gilchrist et al. 2000, Jones, Bovee et al. 1993, Jones and Hauschild 2015, Lisman et al. 2017, Sefton, Lohse, and McAdam 2016, Snoddy and Henderson 1994) and the current study that trainees with low physical fitness, especially low levels of aerobic fitness, have a higher risk of being injured during training; injured trainees have higher attrition compared to uninjured trainees (Hauret et al. 2004, Knapik, Canham-Chervak, Hauret et al. 2001, Wills et al. 2004). It is most likely a combination of these factors (i.e., lower levels of physical fitness and injuries) that contribute to the higher levels of attrition for lower fit trainees, but this is an area that requires further study.

6.9 Study Limitations

There were factors that may have influenced some findings from this study. Attempts were made to minimize the effect from trainees' lack of familiarity with OPAT events by demonstrating the events and allowing them to practice each event. But low motivation or effort and lack of familiarity with the events may have resulted in submaximal efforts by some. The overall methodology and sample size determinations for the study were based on the overarching purpose of the OPAT Longitudinal Validation Study to validate the OPAT among IET trainees. That objective was met, and results for that portion of the study have been reported (USARIEM 2018). But these analyses to evaluate injury and especially attrition outcomes would have benefitted from larger sample sizes, especially among women. In future investigations of these outcomes, larger sample sizes will be important. Sex-dependent physiologic differences on the OPAT events resulted in uneven distributions of sexes when OPAT performance was stratified by either the OPAT PDC or raw event performance bins when we investigated associations of OPAT performance with injury or attrition with the sexes combined. Given that the OPAT has a single sex-neutral standard, it was warranted to combine the sexes for these analyses, but the results with sexes combined should be interpreted cautiously. Considering these sex differences in OPAT performance, findings from the sex-specific analyses are more representative of the associations of OPAT performance with injury or attrition.

6.10 Recommendations and Evidence for Pre-accession Physical Assessment

This study provides evidence for a statistically significant inverse association of the 4-event OPAT at the beginning of IET and subsequent injury and attrition during IET. Based on these

findings, we recommend that the OPAT be fully operationalized as a pre-accession fitness assessment for all recruits.

Based on prior evidence for the relationship between lower physical fitness at the beginning of IET and increased risks for IET injury and attrition, some senior leaders and researchers have advocated for a pre-accession physical fitness assessment (TRADOC 1984, Government Accounting Office 1988, Snoddy and Henderson 1994, Government Accounting Office 1998, USACHPPM 2004a, Niebuhr et al. 2008, Bedno et al. 2013). As far back as 1984, a TRADOC-directed study group that reviewed the Army Trainee Discharge Program noted that many recruits arrived in poor physical condition and that this lack of physical conditioning was a major reason for discharges. The report recommended that a physical fitness screening test be administered at the Military Entrance Processing Stations [MEPS] (TRADOC 1984).

There have been at least two well-documented trial programs that included a pre-BCT physical fitness assessment. From the mid-1990s through 2004, Fort Jackson conducted a physical fitness screening test at the Reception Battalion (1-minute sit-up, 1-minute push-up, and 1-mile run) and a pre-BCT pre-conditioning program (PCP) for trainees that failed the assessment (DiBenedetto 1989, Knapik, Canham-Chervak, Hoedebecke et al. 2001, Knapik et al. 2006). Knapik et al., compared attrition outcomes between three groups of trainees: (1) trainees that passed the screening test and started BCT ("Fit" group), (2) trainees that failed the assessment and attended the PCP before starting BCT ("Low-fit PCP" group), and (3) trainees that failed the assessment but were allowed to start BCT without attending the PCP ("Low-fit, no PCP" group). Among the trainees in the "Low-fit PCP" group, 5% of the men and 10% of the women were discharged from the PCP and did not start BCT. Considering the trainees that did start BCT, the proportion of "Fit," "Low-fit PCP," and "Low-fit, no PCP" trainees that were discharged from BCT were 7%, 6%, and 19%, respectively ($p=0.03$), among men, and 12%, 12%, and 22%, respectively ($p=0.04$), among women. These findings suggest that while trainees in the "Low-fit PCP" group that started BCT had lower attrition during BCT compared to the "Low-fit, no PCP" group, the overall attrition including PCP and BCT was similar (Knapik, Canham-Chervak, Hoedebecke et al. 2001, Knapik et al. 2006).

The second Army program was the ARMS conducted between 2004 and 2006 (Bedno et al. 2013, Niebuhr et al. 2008). The study pilot-tested a two-event pre-accession fitness test battery to assess aerobic fitness and muscular endurance (i.e., a modified Harvard step test and a push-up test). Recruits, no matter their fitness level by these assessments, were allowed to enlist but were followed during BCT and AIT (180 days) for attrition. ARMS test performance was significantly related to risk of attrition within 180 days (Hazard Ratio for failing relative to passing the test; women: 2.27 (1.70-3.04); men: 1.36 (1.13-1.64)).
Similarly, the British Navy instituted a pre-joining fitness assessment in 2006–2007 that consisted of a 2.4-km run (Lunt 2007). Researchers compared the training outcomes between recruits that started the initial training before and after the test was implemented. The pass rate for phase I training increased from 78% (before the test was implemented) to 88% ($p<0.01$) among those that were required to take and pass the assessment before they could start training.

In spite of evidence from the Fort Jackson PCP and the ARMS study, a pre-accession fitness test with/without a PCP was never operationalized across the IET training centers. Possible reasons these programs did not endure include the additional costs, limited number of cadre to staff the programs, and the impact on the "training pipeline" by increasing the length of time required for trainees to graduate from BCT before attending AIT.

Results of this study indicate that the OPAT should be operationalized, not only as a tool to match recruits to an appropriate MOS based on their physical ability, but also as a means of ensuring that new recruits meet a pre-accession minimum fitness standard (at least the Gold PDC standard) to reduce injuries and attrition. Implementation of the OPAT will ensure that new trainees meet the pre-accession fitness standards. Theoretically, an accompanying decrease in incidence of injuries and attrition should occur if all other factors remain constant. Decreasing these negative outcomes could also result in substantial cost savings. For the timeframe 2002 to 2007, the adjusted mean additional medical cost per injured trainee was $872 ($1,094 for women; $826 for men), amounting to an additional annual cost of $21,930,000 for injury (Bulzacchelli et al. 2017). In FY 2016, the cost to recruit and process a new recruit was $22,334 (Training Requirements Office 2016) and IET attrition was 11.4 percent (n=10,795) (Center for Initial Military Training 2018). Considering only the recruiting and processing costs (excluding additional costs for training), a conservative estimated cost for attrition in 2016 is $241,000,000. From these data, it is clear that even small decreases in the incidence of injuries and attrition will result in substantial cost savings.

6.11 Conclusions and Next Steps

We evaluated the association of the 4-event OPAT at the beginning of IET with injuries and attrition during IET. The composite OPAT was associated with injuries among sexes combined and men alone but not women. For sexes combined and men, trainees in the Gray PDC and White category had significantly higher injury risk compared to those in the Black PDC. The composite OPAT was also associated with final attrition risk among sexes combined and men but only for the within group White category compared to the Black PDC. We evaluated the OPAT events as measures of upper- and lower-body muscular power (SPT and SLJ, respectively), lower-body muscular strength (SDL), and cardiorespiratory (aerobic) fitness (IAR); we also examined their associations with injuries and attrition. The strongest and most consistent relationships with injury were with the lower-body muscular strength event (SDL) among men and the aerobic fitness event (IAR) among men and women. The strongest and most consistent relationships with final attrition were the lower-body power event (SLJ) among both sexes, the lower body muscular strength event (SDL) among men, and the aerobic fitness event (IAR) among both sexes. Findings from this study provides new insights into the relationships between muscular power and strength and aerobic fitness with injuries and attrition in IET.

In the future, Army public health agencies conducting surveillance, such as the APHC, and researchers will need routine access to digital OPAT performance data on all accessions, as well as for Soldiers that are required to take the OPAT to reclassify their MOS. As with APFT performance data in the Army Training Management System (ATMS), the accessible OPAT

data must include all iterations of the OPAT during each Soldier's time in Service (i.e., should not be limited to only the most recent iteration of the OPAT).

Future surveillance and research should be conducted to:

- Routinely monitor OPAT and APFT performance among trainees;
- Track injury incidence and attrition during IET and in the first unit of assignment;
- Re-evaluate the associations of OPAT, injuries, and attrition; and
- Continue to study relationships between components of physical fitness, injuries, and attrition in IET and the operational Army.

7 POINT OF CONTACT

The points of contact for this report is the Injury Prevention Division, Army Public Health Center. Questions may be directed to the Injury Prevention Division at usarmy.apg.medcom-aphc.mbx.injuryprevention@mail.mil, or commercial phone 410-436-4655, or DSN 584-4655.

Approved:

BRUCE H. JONES, MD, MPH
Chief
Injury Prevention Division

APPENDIX A

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Glossary

2MR	2-mile run
AFHSB	Armed Forces Health Surveillance Branch
AIT	Advanced Individual Training
ANOVA	Analysis of Variance
APFT	Army Physical Fitness Test
APHC	U.S. Army Public Health Center
ARMS	Assessment of Recruit Motivational Strength
ATMS	Army Training Management System
BCT	Basic Combat Training
BMI	body mass index (kg/m^2)
CFR	Code of Federal Regulation
CI	confidence interval
cm	centimeters
CMTS	Criterion Measure Task Simulations
DA	Department of the Army
DoDI	Department of Defense Instruction
FY	fiscal year
HQDA	Headquarters, Department of the Army
IAR	Interval aerobic run
ICD-10-CM	International Classification of Diseases, 10^{th} Revision, Clinical Modification
IET	Initial Entry Training
K	1,000
kg	kilogram
km	kilometer
lb	pounds
m	meter
MEDCOM	U.S. Army Medical Command
mph	miles per hour
MOS	military occupational specialty
OPAT	Occupational Physical Assessment Test
OSUT	One Station Unit Training
PCP	Pre-conditioning Program
PDC	Physical Demand Category
Q	quartile
RR	relative risk
SDL	Strength Deadlift
SecDef	Secretary of Defense
SLJ	Standing long jump
SPT	Seated power throw
TRADOC	U.S. Army Training and Doctrine Command
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USARIEM	U.S. Army Research Institute of Environmental Medicine