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Epidemiological Report No. S.0007856-11, October 2012
Epidemiology and Disease Surveillance Portfolio

The Soldier-Athlete Initiative: Program Evaluation of the Effectiveness of Athletic Trainers Compared to Musculoskeletal Action Teams in Initial Entry Training, Fort Leonard Wood, June 2010 – December 2011

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ACKNOWLEDGEMENTS

There were many individuals at Ft Leonard Wood who assisted in the successful completion of this project. We would especially like to thank Ms Martha Collins who served as our main POC in the G-3-3 office, finalized the operations order (OPORD) for the project, arranged the periodic briefings to the G-3, and coordinated other aspects of the project. Also assisting in the G-3-3 office was LTC Dean Kucera, MSG James Clayton, and LTC Glasscock. Our POCs in the brigade offices who assured we obtained the APFT and attrition data included MAJ Adam Smith, MAJ Alicia Masson, CPT Jeremy Johns, CPT Julie Hatter, MSG Kirk Lamb, SGM William Lindsey, SFC Kevin Gallagher, SSG Jamal Williams, and Ms Shelley Delamarter. Ms Portia Ellis and Mr Brian Raymond in the Student Processing Branch provided additional information on recruits who were discharged from service. Mr Rodney Chang coordinated our Ft Leonard Wood offices and assured that we had the computer network connections that we needed. Mr Timothy Davis coordinated with us on administering the recruit questionnaire. Individuals serving on the MAT or as ATs who treated injured recruits, maintained the Comprehensive Injury Tracker, or functioned as the certified strength and conditioning specialists included CPT Jennifer Rieger, CPT Justin Zimmerman, SFC Thomas Goyt, Ms Penny Forsythe, Ms Brenda Critchfield, Ms Kammy Powell, Mr Steven Koch, Mr Leslie (Shane) Brookshier, Mr Christopher Hinderliter, Mr Justin Giger, Mr Jacob Fitz, and Mr Brice Atherton. We would also like to thank LTC Brigilda Teneza at the Armed Forces Health Surveillance Center who provided us the injury data from Defense Medical Surveillance System.

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
October 2012	FINAL	June 2010 to December 2011

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The Soldier-Athlete Initiative: Program Evaluation of the Effectiveness of Athlete Trainers and Musculoskeletal Teams in initial Entry Training, Fort Leonard Wood, June 2010-December 2011	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Joseph J Knapik, Bria Graham, Jacketta Cobbs, Diane Thompson, Ryan Steelman, Tyson Grier, Timothy Pendergrass, Nikki Butler, Janet Papazis, Rodney Gonzalez, Bruce H Jones	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
US Army Public Health Command (Provisional), Aberdeen Proving Ground MD	S.0007856-11

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
Rehabilitation and Reintegration Division (R2D), Headquarters, Department of the Army, Office of the Surgeon General, Falls Church VA	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

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

13. SUPPLEMENTARY NOTES

14. ABSTRACT: A program evaluation was conducted at Fort Leonard Wood, Missouri to determine the effectiveness of athletic trainers (ATs) and musculoskeletal action teams (MATs) for reducing injuries, reducing medical attrition, and improving physical fitness. The MAT consisted of a physical therapist, physical therapy technician, two ATs, and two certified strength and conditioning specialists. The evaluation involved two groups (MAT & AT), two phases or periods (baseline (B) & intervention (I)), and three types of training (Basic Combat Training, Military Police One-Station Unit Training [OSUT] and Engineer OSUT). The B phase examined the period before the MAT and ATs were in place, and the I phase after they were in place. Injuries were obtained from medical records. Attrition and Army Physical Fitness Test (APFT) scores were obtained directly from the units involved in the evaluation. The B phase involved 53 training companies (n=7,387 men; 1,816 women) and the I phase involved 44 training companies (5,840 men; 1,817 women). Compared to the B phase, the number of injured male recruits seen in the clinic/hospital in the intervention phase decreased 17% in the MAT group ($p<0.01$) and 22% for the AT group ($p<0.01$); among the women, comparable declines were 22% in the MAT group ($p<0.01$) and 19% for the AT group ($p<0.01$). Compared to the B phase, the number of male injury-related medical encounters seen in the clinic/hospital in the I period declined 19% for the MAT group ($p<0.01$) and 17% for the AT group ($p<0.01$); among the women, comparable declines were 21% in the MAT group ($p<0.01$) and 8% in the AT group ($p=0.33$). When the injury encounters from the clinic/hospital were combined with those of the AT/MAT, the total numbers of male encounters in the I phase (compared to the B) was 11% higher in the MAT group and 44% higher in the AT group; among women I encounters were was 16% higher in the MAT group and 32% higher in the AT group. Compared to the B phase, medical attrition in the I phase was reduced 44% in the MAT group ($p<0.01$) and 17% in the AT group ($p=0.35$) among the men; among the women comparable reductions were 50% for the MAT group ($p<0.01$) and 6% for the AT group ($p=0.79$). Changes in scores from B to I were very small for both groups but total APFT scores (points) tended to remain the same or increase from the B to the I period in the MAT group, while values tended to remain the same or decrease for the AT group. APFT scores were generally higher in the I period for the MAT group when compared to the AT group. In summary, there was little difference between the MAT and AT groups in terms of the injury outcomes. However, there was generally a greater reduction in medical attrition and greater increases in physical fitness in the MAT group, although differences in fitness were minimal. These data favor the MAT model, primarily because of more favorable reductions in attrition.

15. SUBJECT TERMS: Physical fitness, push-up, sit-up, 2-mile run, physical activity, tobacco use, prior injury, menstrual history, attrition, discharge, recycle, basic combat training, one-station unit training, military police, combat engineers

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
Unclassified					Dr. Joseph Knapik
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
Unclassified	Unclassified	Unclassified			410-436-1328

Standard Form 298 (Rev.8/98)
Prescribed by ANSI Std. Z39.18

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1 SUMMARY

1.1 Introduction and Purpose

Recruits in Initial Entry Training (IET) have one of the highest injury incidences of any subgroup in the Army. Many recruits also enter the Army with low levels of physical fitness which can increase the likelihood of injuries and attrition from training. One potential method for reducing injuries and enhancing fitness is through certified athletic trainers (ATs). The Army Training and Doctrine Command proposed that ATs serve in IET at the battalion level to evaluate and treat injuries, offer reconditioning for injured recruits, and provide injury prevention measures (e.g., taping, bracing) and advice. An alternative approach suggested by the Army Medical Department (AMEDD), was the "musculoskeletal action team" (MAT) serving at the brigade level. The MAT consisted of a physical therapist, physical therapy technician, two ATs, and two certified strength and conditioning specialists. The MAT could provide a higher level of medical care than ATs since the physical therapist on the team has received advanced training in musculoskeletal assessment, diagnosis, and treatment, and serves as a credentialed health care provider. Certified strength and conditioning specialists were included on the MAT because many injuries in the military are associated with physical training and these specialists may be able to assure that physical training is carried out in a manner to optimize fitness and minimize injury. The purpose of this paper was to report on the results of a program evaluation examining the effectiveness of ATs and MAT at Fort Leonard Wood, Missouri. Outcomes to determine effectiveness included injuries, training attrition, and physical fitness.

1.2 Methods

This program evaluation compared two groups of IET Soldiers over two phases, and in three different types of IET training. The groups were MAT or AT; the phases (or periods) were baseline or intervention; the training types were Basic Combat Training (BCT), Military Police One-Station Unit Training (OSUT), and Engineer OSUT. OSUT training included the standardized 10-week BCT period and the follow-on Advanced Individual Training that was specific to the occupational specialty. The single MAT group covered 2 BCT battalions, 1 Military Police OSUT battalion, and 1 Engineer OSUT battalion. The ATs were assigned at the battalion level (i.e., one AT for each battalion) and consisted of 1 BCT battalion, 1 Military Police OSUT battalion and 1 Engineer OSUT battalion. The baseline phase involved the period before the MAT and ATs were in place. The intervention phase

involved the period when the MAT and ATs were providing treatment and subject matter expertise to their respective units.

Within the first week of training, recruits completed a questionnaire to provide information on previously known injury risk factors including age, gender, height, weight, tobacco use, physical activity, prior injuries, and menstrual history (for women). Injuries were obtained from two sources: 1) Defense Medical Surveillance System (DMSS) which tracked injury-related visits seen in the clinic/hospital, and 2) a database called the Comprehensive Injury Tracker compiled by the ATs and MAT once those groups were in place in the intervention phase. Army Physical Fitness Test (APFT) scores and recruits that attrited from training were obtained directly from the units involved in the project.

1.3 Results

During the baseline phase (June 2010 through June 2011), data were obtained on 28 training companies in the MAT group (n=3,861 men and 1,068 women) and 25 companies in the AT group (n=3,526 men and 748 women). During the intervention phase (May 2011 through December 2011), data were obtained on 25 training companies in the MAT group (n=3,427men and 1,218 women), and 19 companies in the AT group (n=2,413 men and 599 women).

Injury incidence differed considerably between the MAT and AT groups in the baseline phase so the groups were compared to their own respective baseline periods. Compared to the baseline phase, the number of injured male recruits seen in the clinic/hospital in the intervention period decreased 17% for the MAT group ($p<0.01$) and 22% for the AT group ($p<0.01$); among the women, comparable declines were seen, 22% for the MAT group ($p<0.01$) and 19% for the AT group ($p<0.01$). Results were similar after multivariate correction for known injury risk factors based on questionnaire responses. Among the men, the number of encounters per recruit seen in the clinic/hospital declined from the baseline to the intervention period 19% for the MAT group ($p<0.01$) and 17% for the AT group ($p<0.01$). Among the women, the number of encounters per recruit seen in the clinic/hospital declined from the baseline to the intervention period 21% for the MAT group ($p<0.01$) and 8% for the AT group ($p=0.33$). When the encounters from the clinic/hospital were combined with those of the Comprehensive Injury Tracker, the total numbers of encounters among men was 11% higher in the MAT group and 44% higher in the AT group in the intervention phase; the total numbers of encounters among women was 16% higher in the MAT group and 32% higher in the AT group in the intervention phase. ATs and the MAT handled 32% of total injury-related encounters in the intervention phase with the clinic/hospital handling 68% of total encounters.

Compared to the baseline period, medical discharges (attrition), in the intervention period declined 38% in the MAT group ($p<0.01$) and 14% in the AT group ($p=0.35$) among the men. Comparable declines among the women were 49% in the MAT group ($p<0.01$) and 11% in the AT group ($p=0.59$). The change in the number of recruits who were *not* discharged in the intervention period amounted to 6, 30, 3, and 8 recruits per 1,000 for MAT men, MAT women, AT men and AT women, respectively.

APFTs were generally not administered within the first week of training but rather an average of more than two weeks after the start of training. Since several physical training sessions were likely to have occurred, and since recruits were likely to have considerably increased their physical fitness in this time, the first APFT could not serve as an initial level of fitness. Only the final APFT was considered in the analyses. Changes in final APFT scores from the baseline to the intervention period were minimal in both groups. Nonetheless, MAT group push-up and sit-up values tended to remain the same or increase from the baseline to the intervention period, while those of the AT group tended to remain the same or decrease. On the other hand, 2-mile run performance generally improved in both the MAT and AT groups. Total APFT points tended to remain the same or increase from the baseline to the intervention period for the MAT group, while values tended to remain the same or decrease for the AT group. However, the baseline performance of the MAT was lower than that of the AT group on most comparisons making it easier for the MAT group to show improvements. Nonetheless, when the MAT and AT groups were directly compared in the intervention period, the MAT group had higher performance on a greater number of comparisons.

1.4 Conclusions and Recommendations

There were few differences between the MAT and AT groups in terms of the injury outcomes: both groups demonstrated similar reductions in the proportion of injured recruits and in the number of injury encounters seen in the clinic/hospital during the intervention period. Despite the reduction in the number of injured recruits, the total number of injury encounters (clinic/hospital encounters plus AT/MAT encounters) increased in both groups, likely because of the more convenient access to medical care provided by the MAT/AT. In terms of medical attrition, there was a greater reduction in the MAT group. In terms of physical fitness, improvements in the intervention period were greater in the MAT group than in the AT group when the groups were compared to their respective baselines, although these performance increases were small. When the MAT and AT group were directly compared in the intervention period, the MAT had higher performance in a greater number of comparisons. Based on these data, it is recommended that the MAT group model be favored over the AT group model, primarily because of more favorable changes in attrition.

If the MAT or AT models are implemented, there needs to be continued accountability for recording all visits through the Comprehensive Injury Tracker or similar mechanisms. Cost and manpower effectiveness of such imbedded medical assets need to be calculated. Although the MAT and ATs accounted for about 1/3 of the medical visits, the encounters/day were low suggesting that these models of care may be clinically inefficient, although the MAT and ATs also provided injury prevention advise to the cadre that may not be reflected in the data collected. In terms of attrition prevention and fitness enhancement, it may be effective to utilize other non-medical experts, such as those graduating from the newly developed Army Master Fitness Trainer course.

Further follow-up should be performed on units that have ATs and MATs. This study covered a period when the ATs and MAT had just arrived at Fort Leonard Wood. Lessons learned here and the experiences of the ATs and MATs will likely be used to modify how the ATs and MAT operate. Outcomes may be different in the longer term.

2 REFERENCES

See Appendix A for a listing of references used within this report.

3 AUTHORITY

Under Army Regulation 40-5,[1] the US Army Center for Health Promotion and Preventive Medicine (now the AIPH) is responsible for providing program evaluations and epidemiological consultation services related to injury prevention and control. This project was funded by the R2D, Headquarters, Department of the Army, Office of the Surgeon General, Falls Church VA to evaluate the effectiveness of MATs and ATs using injury, attrition and fitness metrics. The project was reviewed by the AIPH Human Subject Protection Office employing the criteria of the Council of the State and Territorial Epidemiologists.[2] It was determined that this project constituted public health practice.

4 INTRODUCTION

Recruits in Initial Entry Training (IET) have one of the highest incidences of musculoskeletal injuries of any subgroup in the Army.[3-6] This not only affects Soldier preparation, but can also result in discharges due to medical attrition[7, 8] which reduces military manpower. Reducing injury rates and injury-related attrition is a multi-factorial task that includes, but is not limited to, command emphasis, training, and enforcement of evidence-based injury prevention techniques.[3, 9] Well-trained, combat-ready Soldiers are most advantageously produced by creating a program

that optimizes physical performance, prevents injuries, and facilitates early identification and management of injuries when they do occur.

One potential method proposed for reducing and managing injuries is certified athletic trainers (ATs). ATs were first proposed for Basic Combat training (BCT) by Brigadier General James Schwitters when he was the commander of the Fort Jackson Training Center in South Carolina. His concept was to have ATs at the battalion level tasked with providing early treatment of injured recruits and injury prevention advice to the battalion. In sports, ATs evaluate injuries, offer immediate care, and provide on-site injury management during practice and games. In addition, ATs determine rehabilitation and/or reconditioning strategies for injured athletes. Treatment programs can include long and short term goals and an appraisal of what the athlete can realistically be expected to achieve from the program. The AT documents all care as part of the athlete's permanent medical record and accepts responsibility for recording details of the athlete's health status. ATs also provide preventative measures such as taping or bracing prior to physical training in addition to therapeutic treatment that may prevent or reduce the severity of injury and contribute to a more rapid return of the athlete to full activity. ATs may also work with medical staff to provide therapy for athletes who are recovering from injuries and may show athletes how to build their strength and endurance to presumably avoid further injury. They may also be involved in prevention efforts by recommending injury-prevention strategies. ATs are not independent medical care providers and they must operate under the supervision of a licensed physician.[10]

Recruits in IET can be seen as Soldier-athletes in training.[11] Recruits perform repetitive physical tasks like foot marching, drill and ceremony, rifle marksmanship, repeated obstacle course circuits, and the like, which can potentially result in a high number of overuse-type injuries.[5, 12-15] The types of injuries commonly seen in Army IET recruits[12-14] are very similar to those commonly seen in athletics[16-22], including sprains, strains, tendonitis, bursitis, contusions, and stress fractures.[11] Thus, it would seem reasonable that the treatment skills and injury prevention methods applied by ATs in sports and exercise situations may also be applicable to recruits in IET.

In late 2009, the Rehabilitation & Reintegration Division (R2D), Headquarters, Department of the Army, Office of the Surgeon General, was tasked with determining the efficacy of ATs in IET. The R2D reviewed literature on BCT injury prevention, and sought information from various BCT locations and the Army Institute of Public Health (AIPH). After their literature review, the R2D suggested an alternative approach to ATs which involved a "musculoskeletal action team" (MAT). The MAT would be assigned at brigade level (or equivalent) and would consist of a physical therapist, physical therapy assistant or technician, two ATs, and two certified strength and conditioning specialists. As noted above, ATs can provide

certain types of injury assessment and treatment and have emergency management skills that are valuable where there is a higher risk for acute injuries. However, ATs are not licensed, independent providers in the Army Medical Department (AMEDD), and they must have physician oversight to practice in any venue. Physical therapists have received advanced training in musculoskeletal assessment, diagnosis, and treatment, and provide a higher level of medical care in the AMEDD as credentialed health care providers. Certified strength and conditioning specialists were included as part of the MAT because many injuries in the military are associated with physical training.[23-26] Certified strength and conditioning specialists may be able to assure that physical training exercises are carried out in a manner to optimize mission readiness and minimize the incidence of injury.

In December 2009, the R2D briefed LTG Schoomaker (Army Surgeon General from 2007 through 2011) on the proposal for the MAT and he endorsed and approved the plan. In February 2010, the R2D briefed LTG Hertling (Deputy TRADOC Commander for IET Training from 2009 through 2011) on the MAT plan. LTG Hertling still favored the ATs alone but also endorsed the MAT. After these briefings, TRADOC and OTSG decided they would field ATs and a MAT at Fort Leonard Wood, Missouri and evaluate the relative effectiveness of the two programs at this location.

The purpose of this paper is to report on the results of the program evaluation examining the effectiveness of ATs and MAT at Fort Leonard Wood, Missouri. Metrics to determine effectiveness included injuries, training attrition, and physical fitness. The units selected for evaluation involved three BCT battalions, two military police (MP) one-station unit training (OSUT) battalions and two engineer (ENG) OSUT battalions. With regard to the injury data this evaluation considered 1) whether or not there were changes in the proportion of injured recruits seen in the clinic/hospital after the MAT and ATs were in place, 2) whether or not there were changes in the proportion of injury-related encounters (visits) in the clinic/hospital after the MAT and ATs were in place, and 3) whether or not the total number of encounters (clinic/hospital visits plus MAT/AT encounters) changed when the MAT and ATs were in place.

5 BACKGROUND

5.1 Injury Incidence in Basic Combat Training and Infantry OSUT

Cumulative injury incidence (proportion of trainees who experience one or more injuries during training) and injury rates (injured trainees per month) have been examined in a number of previous basic training studies and in infantry OSUT.[13, 15, 27-40] Summary data from these studies are shown in Table 1. US Army BCT was extended from 8 to 9 weeks in October 1998 and thus studies performed before and

after this time are separated in Table 1 to reflect the increased time at risk in the latter investigations. Two investigations involved infantry OSUT which was 12 weeks long at the time of the data collection. BCT was extended to 10 weeks in 2008.

Data collection techniques differed in the investigations cited in Table 1. Many investigations used medical records screening,[13, 32, 37, 41-44] but other studies used medical surveillance systems[39, 40, 45] or questionnaires.[33] With regard to injury definitions, most studies have looked at cases where trainees reported to a medical care provider for any type of physical damage to the body,[15, 32, 37, 39, 40, 43, 44] but other studies have included only musculoskeletal injuries[13] or lower extremity overuse injuries.[13, 42] One study used self-reporting and included any injury regardless of whether or not the trainees sought medical care.[33]

Table 1. Cumulative Injury Incidence and Injury Incidence Rates during Army Basic Combat Training and Infantry One-Station Unit Training

Length of Training (weeks)	Study (Reference Number)	Year Data Collected	Recruits (n)		Cumulative Injury Incidence (%)		Injury Incidence Rate (% / month)	
			Men	Women	Men	Women	Men	Women
8 weeks	Kowal et al. 1978[46a]	1978	347	770	26.2	62.0	13.1	31.0
	Bensel and Kisk 1983[32]	1980	1,840	644	20.7	41.2	10.4	20.6
	Jones et al. 1993[13]	1984	124	186	27.4	50.5	13.7	25.3
	Bell et al. 2000[41]	1988	509	352	27.0	57.0	13.5	28.5
	Westphal et al. 1995[37]	1994	ND	165	ND	66.7	ND	33.3
	Jones et al. 1996[42]	1996	159	84	41.5	65.5	20.8	32.8
	Knapik et al. 2001[15]	1998	604	305	30.8	58.0	15.4	29.0
9 weeks	Canham-Chervak et al. 2000[43]	1998	655	498	30.0	65.3	13.3	29.0
	Knapik et al. 2001[44b]	2000	682/441	579/554	13.5/16.9	36.1/46.8	6.0/7.5	16.0/20.8
	Knapik et al. 2005[45bc]	2003	442/569	295/377	19.5/27.9	41.0/47.7	8.7/12.4	18.2/21.2
	Knapik et al. 2008[39]	2007	2,147	915	36.9	64.7	16.4	28.8
12 Weeks (Infantry OSUT)	Jones et al. 1993[31]	1988	303	ND	45.9	ND	15.3	ND
	[d]	1996	768	ND	48.0	ND	16.0	ND

Abbreviations:
ND = no data collected on gender listed
OSUT=One Station Unit Training

Notes:
[a] Injury data from self-report questionnaire
[b] Cohort study with two groups
[c] Injury data from surveillance system
[d] Previously unpublished data

5.2 Injury Risk Factors

In addition to cumulative injury incidence and injury rates, a number of injury risk factors have been identified in BCT. Intrinsic risk factors have included female gender,[5, 13, 15, 29-35] older age,[5, 15, 31, 38, 47] low aerobic fitness,[5, 13, 15, 29, 30, 37, 48, 49] low muscular endurance,[5, 15, 31] cigarette smoking prior to BCT,[5, 15, 31, 48-50] low physical activity prior to basic training,[5, 13, 15, 30, 31, 48] and menstrual irregularities.[5] Extrinsic risk factors have included longer running mileage in training[51] and training in the summer.[52] Multivariate analyses have shown that cigarette smoking prior to BCT, low levels of aerobic fitness, and low levels of physical activity prior to BCT were independent intrinsic injury risk factors.[5, 15, 31, 53]

5.3 Athletic Trainers

In 2007, one publication mapping the AT literature found 8,678 citations, with 35% of these in 6 medical journals.[54] Although there have been several calls for more evidence-based medicine and outcomes research[55, 56] some of the more basic questions in athletic training have not been adequately addressed to date. One of the more fundamental questions is whether or not ATs are effective in reducing the incidence of injuries and/or returning injured athletes more quickly to the athletic field. A review of the literature revealed a few studies that had examined some aspects relating to the effectiveness of ATs and these are reviewed below. Interestingly, these studies deal with injured workers rather than athletes.

Zimmerman[57] reviewed a number of cases where ATs had apparently been employed in industrial settings. In one case, two ATs were employed as part of the General Motors (GM) Saginaw Division (Michigan) rehabilitation/fitness center. From 1988-1991 it was estimated that the Saginaw Division saved over $3,500,000 by conducting rehabilitation in-house rather than outsourcing. Another case (also reported by Tonti et al.[58]) involved the Walbro Corporation in Cass City/Caro Michigan which employed over 300 people to build small engine carburetors and fuel pumps. Injured workers made use of a rehabilitation facility with a 21-piece Nautilus set and aerobic exercise equipment. Money spent on the equipment/facility was recouped within 10 months and there was a 79% reduction in occupational time off because of injury or illness. However, it appears that the fitness center was used by 40% of employees and it is not clear if the finding reflect increased physical activity on the part of the workers or clear benefits from the AT part of the program. Previous studies have shown that just providing exercise facilities to employees can

reduce medical costs and absenteeism.[59-61] Other cases cited by Zimmerman involved Central Michigan University and Wilson Brands Corporation but from the descriptions provided it is not clear if these programs involved ATs or other forms of rehabilitation. Central Michigan University employed 2,364 people and Zimmerman reported that during the 6 months that a "healthletics" program was in place, $213,244 was saved because employees were able to return to work a total of 2,423 days earlier. Wilson Brands Corporation had 1,200 employees and Zimmerman reported that over comparable 6-month periods in 1988 and 1990, lost duty days were reduced by half and worker's compensation cases requiring surgery were reduced by 95%. The original articles cited by Zimmerman[57] for the latter two cases could not be obtained because the referencing appeared to be incorrect.

Larson et al.[62] evaluated the effectiveness of a hospital-based internal employee health program that incorporated ATs in the rehabilitation process. Worker's compensation claims were reviewed for a 23-month period before the program and a 23-month period after the program was in place. There was a greater number of lost-work day *claims* in the post-program period (62 vs. 128, $p<0.01$). Despite this, work days lost were reduced from 100±120 days in the pre-program period, to 45±69 days in the post-program period (mean±standard deviation, $p<0.01$). Four weeks after a claim was issued, 55% of post-program injured workers had resumed work compared to 36% of pre-program injured workers ($p<0.01$). The decision on removing or returning an employee to work was made by a physician, not the ATs. Thus, after the ATs were available for rehabilitation and counseling, there was a reduction in the number of lost work days and injured workers returned to work more quickly.

Cheng and Hung[63] performed a randomized control trial comparing a clinic-based work hardening program to that of a work-place based program for the rehabilitation of work-related rotator cuff injuries. The clinic-based approach was traditional, involving rehabilitation exercises and work simulations at locations away from work. The work-place program involved a "job coach" who used a rehabilitation program designed for rehabilitating rotator cuff injuries experienced in athletics (although the job coach was not an AT). The work-place rehabilitation program included shoulder stretches, shoulder strengthening exercises, and scapular control exercises, in addition to ergonomics education and job specific activities. After 4 weeks, the participants in the work-based program reported greater improvements in shoulder pain and disability (25% vs. 40%, $p=0.03$), and generally greater objective improvements in functional capacity (e.g., active shoulder flexion, arm lifting force, carrying force). After 4 weeks 71% of the work-place program participants had returned to work compared to 37% of the clinic-based participants ($p<0.01$).

Franche et al.[64] performed a systematic literature review on the effectiveness of various return-to-work interventions for reducing disability duration. Ten studies met

their review criteria and were of sufficient quality to be included in the review. There was strong evidence that disability duration was reduced by work accommodation offers and contact between a health care provider (HCP) and the workplace. There was moderate evidence that disability duration was reduced by early contact with the workplace by the worker, an ergonomic worksite visit, and presence of a return-to-work coordinator.

Subsequently, Franche et al.[65] examined the effectiveness of various return-to-work strategies on the duration of workplace absences among Ontario, Canada firms that had workers' compensation coverage. They examined six potential predictors and 20 potential confounders. The potential predictors included 1) early contact with the worker by the workplace, 2) work accommodation offer, 3) contact between the HCP and the workplace, 4) advice from the HCP to the workplace, 5) receiving an ergonomic worksite visit, and 6) presence of a return-to-work coordinator. The potential confounders included factors like age, gender, education, income and other covariates. Outcomes included self-reported workplace absence duration and durations obtained from workplace compensation claims (administrative duration). Not surprisingly, absence duration was reduced by workplace accommodation offer and acceptance by the injured worker. HCP advice to the workplace on how to prevent injury or the recurrence of injury also reduced both self-reported and administrative workplace absence duration. However, the presence of a return-to-work coordinator had no effect on either outcome. These data suggest that an HCP who offers injury-prevention advice to the workplace can reduce the duration of absences after a workplace injury.

The Navy developed a Sports Medicine and Rehabilitation (SMART) Center for recruits at the Marine Corps Recruit Depot at San Diego. This center had a sports medicine physician, podiatrist, physical therapist, physician's assistant, dietitian, chiropractor, orthopedic technician, physical therapy technician, and corpsman [66]. It is very similar in concept to the MAT but obviously provides a higher level and more variety of medical care. Drozd[67] evaluated the effectiveness of the SMART Center by examining medical attrition from the Marine Corps School of Infantry. Medical attrition in fiscal year (FY) 1996 was compared to medical attrition in FY 1997. FY 1997 medical attrition was only available for the first 6 months so a "weighted average" was calculated to estimate 1-year attrition. It is not clear from the article exactly how this weighted average was calculated. Another problem with this analysis was the fact that the SMART Center opened on 1 August 1996. Since FY 1996 ranged from October 1995 to September 1996, some of the FY 1996 data would include medical data for 2 months after the Center had been in operation. With these qualifications in mind, the author found that 160 trainees were discharged for medical reasons in FY 1996 compared to an estimated attrition of 50 for FY 1997. The return to duty rate was 57% in FY 1996 and a projected 75% in FY 1997.

More conclusive data may have been obtained by comparing the first 6 months of both FYs.

In summary, there were few studies that had evaluated the effectiveness of ATs and the available data is in occupational settings and not in athletics. Available studies suggest that ATs or "AT-like" programs can be cost effective compared to outsourcing medical care.[57] In addition, ATs or "AT-like" programs can result in a more rapid return to work,[57, 62, 64, 65] a reduction in lost work days,[62-64] and a more rapid improvement in worker functional capacity.[63] In Marine Corps basic training, a multidisciplinary medical team, similar in concept to the MAT, appears to have reduced medical attrition.[67]

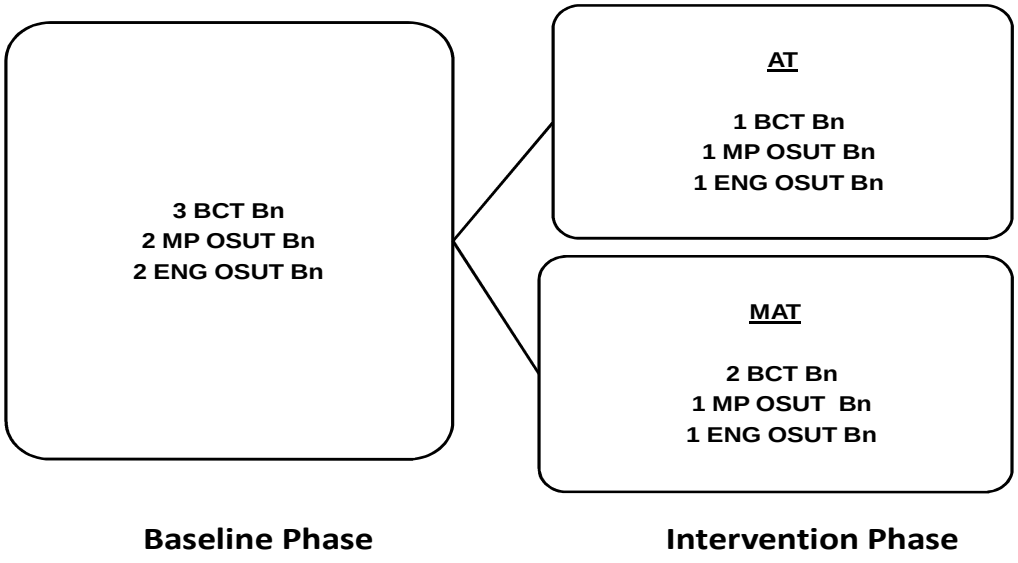
6 METHODS

6.1 Design

Figure 1 shows the design of the project. The project was a program evaluation comparing two groups of IET Soldiers over two phases and involving three different types of training. Groups were either MAT or AT. Phases (or periods) were either baseline or intervention. Training types were either BCT, MP OSUT, or ENG OSUT. The MAT group received injury treatment and subject matter expertise on physical training and injury prevention from a single MAT. The MAT group had 2 BCT battalions, 1 MP OSUT battalion, and 1 ENG OSUT battalion. The AT group recruits received injury treatment and subject matter expertise on physical training and injury prevention from ATs assigned at battalion level. The AT group consisted of 1 BCT battalion, 1 ENG OSUT battalion and 1 MP OSUT battalion. The AT group had a separate AT for each of the 3 battalions. The MAT consisted of a physical therapist, physical therapy technician, two ATs, and two certified strength and conditioning specialists. The plans, procedures, and training for the MAT were developed by the R2D Musculoskeletal Action Plan Working Group in the Office of the Surgeon General. The plan, procedures, and training for the ATs were provided in coordination with personnel from Ft Jackson, South Carolina.

The two project phases were either baseline or intervention. The baseline phase examined the period before the MAT and ATs were in place. The intervention phase examined the units when the MAT and ATs were providing treatment and subject matter expertise. The baseline period encompassed training cycles between June 2010 and June 2011. The intervention period encompassed training cycles between May 2011 and December 2011. The MAT and ATs did not begin their activities within a unit until that IET unit *began* their training cycle. Thus, there was no phase overlap within units (i.e., no situation in which a unit had part of a cycle in the baseline period and part in the intervention period). IET cycles that crossed "Exodus" were not considered in the analysis. Exodus is a two-week period in late

December and early January when no training is conducted and recruits are allowed to return home.



[2]

Figure 1. Project Design

6.2 Procedures

Within the first week of training, recruits completed the questionnaire in Appendix B. Responses to this questionnaire were used to control for known injury risk factors in the analysis, as discussed in the introduction. The questionnaire contained items on age (birth date), gender, height, weight, tobacco use, physical activity, prior injuries, and menstrual history.

Initial and final Army Physical Fitness Test (APFT) scores were obtained directly from the units. For the APFT, recruits completed as many push-ups as possible in two minutes, as many bent-knee sit-ups as possible in two minutes, and a two-mile run for time. The three fitness test events were administered by drill sergeants using well standardized procedures.[68] For the push-up, the recruit lowered his or her body in a generally straight line to a point where the upper arms were parallel to the ground, and then returned to the starting point with elbows fully extended. For the sit-up, the recruit's knees were bent at a 90° angle, fingers were interlocked behind the head, and a second person held the recruit's ankles, keeping the heels firmly on the ground. The recruit raised the upper body to a vertical position so that the base of the neck was anterior to the base of the spine and then returned to the starting

position. Scores were the number of push-ups or sit-ups successfully completed within separate 2-minute periods. The performance measure for the run was the time to complete the 2-mile distance. Time between events was no less than 10 minutes. A composite APFT score was calculated using an age and gender-related scoring system.[68] During all physical training, drill sergeants were required to follow the training principles specified in Training Circular (TC) 3-22.20 (Army Physical Readiness Training)[68] and the certified strength and conditioning specialists periodically verified that this was the case.

Recruits that attrited from training, as well as the date and reason for the discharge, were provided by the training companies. Where possible, these data were verified from data in the Directorate of Human Resources, Trainee Student Processing Branch at Fort Leonard Wood. Attrition was defined as discharge from service. Discharges were recruits who were not suitable for service in the Army and were formally released from their service commitment during the course of IET. There were numerous reasons for which a recruit could have been discharged but most fell into two categories: 1) medical conditions that existed prior to service or developed during BCT, or 2) poor entry-level performance. The latter category is often the result of inability to adapt to the military environment because of lack of ability (cannot adequately perform critical military tasks) or for psychosocial reasons (motivation, inability to follow orders, personality problems, commission of serious offenses, etc.). For the purposes of this study, any discharge for a reason other than an injury-related medical condition was defined as a “non-medical” discharge.

Injuries data were obtained from two sources: 1) Defense Medical Surveillance System (DMSS) and 2) the Comprehensive Injury Tracker, an Excel database compiled by the ATs and MAT once those groups were in place in the intervention phase. The DMSS data was provided by the Armed Forces Health Surveillance Center (AFHSC). The AFHSC regularly compiles data on ambulatory (outpatient) encounters occurring within military treatment facilities, as well as those occurring outside the medical treatment facilities (civilian care) and paid for by the Department of Defense. A list of recruits from the units being evaluated in the baseline and intervention phases and the dates of their training cycles were provided to the AFHSC. The AFHSC returned visit dates and International Classification of Diseases, Revision 9, Clinical Modification (ICD-9) codes for all outpatient medical visits during the training cycle timeframe. Five injury indices were calculated from the data provided by the AFHSC. These indices included the Installation Injury Index (III), the Modified Installation Injury Index (MIII), the Training Related Injury Index (TRII), the Comprehensive Injury Index (CII), and the Overuse Injury Index (OII). These indices include specific ICD-9 codes, as described previously.[35] The III and TRII were developed by personnel at the AFHSC. The III has been used to compare overall injury rates (acute and overuse) among military posts and is reported on a monthly basis at the AFHSC website (http://afhsc.army.mil). The MIII,

TRII, CII, and OII were developed by personnel in the Injury Prevention Program at the AIPH. The MIII captures a greater number of injuries than the III, including more overuse-type injuries. The TRII is limited to lower extremity overuse injuries and has been used to compare injury rates among Army basic training posts. It is reported monthly to the TRADOC surgeon. The CII captures all ICD-9 codes related to injuries defined as physical damage to the body as a result of an energy exchange.[69, 70] The OII captures the subset of musculoskeletal injuries presumably resulting from cumulative microtrauma (overuse injuries) such as stress fractures, stress reactions, tendonitis, bursitis, fasciitis, arthralgia, neuropathy, radiculopathy, shin splints, synovitis, sprains, strains, and musculoskeletal pain (not otherwise specified).

In addition to the DMSS injury data, ATs and the MAT members providing medical care recorded patient encounters in the Comprehensive Injury Tracker. This database contained one encounter on each line of a spreadsheet and included information on whether the encounter was a new injury or a follow-up of a previous injury, the general category of the injury (overuse, traumatic, other), the injury diagnosis, anatomical location, and the activity associated with the injury. These data were not included in the DMSS data. Because the Comprehensive Injury Tracker was a de-identified database it was not possible to link the data to individual cases in the DMSS.

6.3 Data Analysis

Data were compiled and analyzed using the Statistical Package for the Social Sciences (SPSS), Version 18.0. Age was calculated from the date of birth on the questionnaire to the date of the start of training. Body mass index (BMI) was calculated as weight/(height X height) (obtained from the questionnaire).[71] Age and physical characteristics (height, weight, BMI) were analyzed using a two-way analysis of variance (ANOVA) with two groups (MAT and AT) and two phases (baseline and intervention).

Cumulative injury incidence was calculated as the number of recruits with ≥ 1 injury/the total number of recruits X 100%, using the DMSS data. The Chi-square statistic was used to examine differences between the MAT and AT group in the baseline phase. Since there were differences in the baseline phase for many comparisons, subsequent analysis involved chi-squares examining differences between the baseline and intervention phase for the MAT and AT groups separately. The magnitude of the change from the baseline to the intervention phase was examined and compared between the groups. Risk ratios (RR) and 95% confidence intervals were used for this latter comparison.

Cox regression (survival analysis) was used to examine the association between the time to the first CII injury (DMSS data) and phase, as well as other potential injury risk factors from the questionnaire. Because of differences in injury incidence in the baseline phase, each group and training type was analyzed separately. For each analysis, once a recruit had an injury, his or her contribution to time in training was terminated (censored). Those who attrited from training had their time censored at the day they left training, unless their time had already been censored as the result of an injury. All potential risk factors were entered into the regression models as categorical variables. Continuous variables were converted to categorical variables based on recommendations from the literature or findings from previous basic training studies.[5, 72, 73] Age was separated into 5 year groups (<20.0, 20.0-24.9, 25.0-29.9 and ≥30 years). BMI was separated into 4 groups (<18.5, 18.5-24.9, 25.0-29.9 and ≥30 kg/m^2) as recommended by the National Institute of Health.[74] Physical activity questions were categorized based on recommended activity levels specified by the American College of Sports Medicine.[75] Some categories in nominal and/or ordinal variables were combined to increase statistical power. For all Cox regressions, simple contrasts were used, comparing the injury hazard at a baseline level of a variable (defined with a hazard ratio (HR) of 1.00) with other levels (strata) of the same variable. Univariate Cox regressions established the individual associations between time to first injury at each stratum of a variable. Variables were included in a multivariate backward stepping Cox regression if they achieved $p<0.10$ in the univariate analyses [76]. Multivariate Cox regressions established the effect of phase on injury risk with other significant injury risk factors included.

Injury clinic/hospital recruit encounters from the DMSS and Comprehensive Injury Tracker were compiled by group, phase, and training type. Encounters per recruit were calculated as the total number of encounters divided by the total number of recruits. For the DMSS data, a one-way ANOVA was used to compare the number of encounters in the baseline phase between the MAT and AT. Since there were differences in the baseline phase for many comparisons, subsequent analysis involved an independent samples t-test examining differences between the baseline and intervention phase separately for the MAT and AT groups. The ratio of the change in encounters per recruit from the baseline to the intervention phase was examined and compared between the MAT and AT groups. It was not possible to perform an ANOVA on the Comprehensive Injury Tracker data since the file was de-identified and individuals could not be accurately identified. It was possible to calculate the ratio of the change in encounters per recruit from the baseline to the intervention and compare these between the MAT and AT groups. Data in the intervention phase from the DMSS and the Comprehensive Injury Tracker were combined to examine the total number of encounters in the intervention phase; these were compared to the baseline phase to see if the total number of encounters changed.

Attrition from training was calculated as the number of recruits discharged/ the total number of recruits X 100%. The Chi-square statistic was used to examine differences between the MAT and AT group in the baseline phase. Subsequent analysis involved chi-squares examining differences between the baseline and intervention phase for the MAT and AT groups separately. The magnitude of the change from the baseline to the intervention phase was examined and compared between the MAT and AT groups. Risk ratios (RR) and 95% confidence intervals were used for this latter comparison.

Final APFT raw scores were analyzed using a two-way ANOVA (groups X phases). There were a number of significant group X phase interactions. To determine the meaning of these interactions the baseline and intervention periods were analyzed separately within the MAT and AT groups using a one-way ANOVA. Also, because of some differences in age, body weight, and BMI between the baseline and intervention phases, an analysis of covariance (ANCOVA) was used to examine APFT scores while controlling for these variables.

7 RESULTS

Table 2 shows the total number of recruits and training cycles by group (MAT or AT), phase (baseline or intervention), and training type (BCT, MP, or ENG). There were very few women in the ENG OSUT training and thus these data must be interpreted cautiously. Cycles in the baseline phase had start dates between 7 June 2010 and 25 May 2011 and graduation dates between 16 September 2010 and 7 June 2011. Cycles in the intervention phase had start dates between 12 May 2011 and 26 September 2011 and graduation dates between 7 July 2011 and 22 December 2011. As noted above, cycles in the baseline phase that crossed Exodus were not included in the analyses. Not all subjects completed all parts of the investigation so sample sizes are shown in many of the subsequent tables.

Table 2. Number of Recruits and Cycles by Group, Phase, and Training Type

Group	Type of Training	Baseline				Intervention			
		Men (n)	Women (n)	Total (n)	Cycles (n)	Men (n)	Women (n)	Total (n)	Cycles (n)
MAT	BCT	2,748	819	3,567	19	2,423	1,043	3,466	18
	MP	764	235	999	6	417	145	562	3
	ENG	349	14	363	3	587	30	617	4
AT	BCT	1,059	338	1,397	8	986	347	1,333	8
	MP	1,353	386	1,739	10	609	233	842	5
	ENG	1,114	24	1,138	7	818	19	837	6
MAT	ALL	3,861	1,068	4,929	28	3,427	1,218	4,645	25
AT	ALL	3,526	748	4,274	25	2,413	599	3,012	19

Abbreviations: MAT=musculoskeletal action team group; AT=athletic trainer group; BCT=Basic Combat Training; MP=military police training; ENG=engineer training

7.1 Age and Physical Characteristics of Recruits

Table 3 shows the age and physical characteristics of the recruits by group, phase, and training type. As noted in the Data Analysis section, data were analyzed using a two-way ANOVA. P-values for the two main effects (groups and phases) and interaction (groups X phases) are shown.

Among recruits in BCT, men and women in the baseline phase were an average of 1.8 to 2.2 years older than those in the intervention phase. Men in the baseline phase were 3 to 5 lbs heavier than in the intervention phase and this contributed to an average 0.5 to 0.7 kg/m^2 higher BMI in the baseline phase since height differed little between phases. Women differed little in the two phases for height, weight, or BMI.

For the MP recruits, the average age of men and women in the MAT group differed little in the baseline and intervention phases; however, men and women in the AT group were an average of 1.4 years older in the baseline phase compared to the intervention phase. The average height of the men and women differed little by group or phase. The average weight and BMI of the men in the MAT group differed little in the baseline and intervention phases. However, the average weight and BMI in the AT group was greater in the baseline phase compared to the intervention phase (6 lbs and 0.7 kg/m^2, respectively). The average weight and BMI of the women in the AT group differed little in the baseline and intervention phases. However, women in the MAT group in the baseline phase averaged 3 lbs heavier than MAT women in the intervention phase and this contributed to an average 0.7 kg/m^2 higher BMI in the MAT group baseline phase women.

For the ENG recruits, the trend in age was similar to that seen in the BCT recruits. Men and women in the baseline phase tended to be older than those in the intervention phase (0.5 to 1.6 years) for both the MAT and AT groups. Women in the MAT group were taller than those in the AT group (1.3 and 1.4 in). MAT group women differed little by phase in weight or BMI. However, AT group women in the intervention phase were an average of 7 lbs heavier and had a 0.9 kg/m^2 higher BMI but these were not statistically significant, presumably because of the small sample size. For men, there was little difference between groups or phases for height, weight, or BMI.

When all training groups were combined, both men and women in the baseline phase averaged about 1.5 years older than subjects in the intervention phase. Also, male and female recruits in the MAT group averaged about 0.5 years older than

those in the AT group. Average height was identical between groups and phases for men, and almost identical for women. Men in the baseline group were an average of 3 lbs heavier than those in the intervention group, although for the women the average body weight differed by only 1 lb between groups or phases. Finally, men's average BMI was 0.5 kg/m^2 higher in the baseline phase compared to the intervention phase; the women's average BMI was almost identical between groups and phases.

Table 3. Age and Physical Characteristics by Group, Phase, and Training Type

Type of Unit	Gender	Variable	Phase	MAT		AT		ANOVA p-values		
				N	M±SD	N	M±SD	Group (MAT vs. AT)	Phase (Baseline vs. Intervention)	Group X Phase
BCT	Men	Age (yrs)	Baseline	2748	22.8±4.6	1059	23.3±4.9	0.35	0.05	0.18
			Intervention	2423	21.0±4.2	986	21.1±4.4			
		Height (in)	Baseline	2738	69.8±3.0	1058	69.9±2.9	0.93	0.68	0.31
			Intervention	2415	69.9±3.0	981	69.9±2.9			
		Weight (lbs)	Baseline	2738	174±28	1058	176±29	0.60	0.13	0.28
			Intervention	2410	171±28	983	171±29			
		BMI (kg/m^2)	Baseline	2732	25.1±3.7	1057	25.3±3.7	0.46	0.07	0.50
			Intervention	2407	24.6±3.6	981	24.6±3.6			
	Women	Age (yrs)	Baseline	818	22.6±4.7	338	22.9±4.9	0.39	0.04	0.58
			Intervention	1043	20.8±4.3	347	20.8±4.5			
		Height (in)	Baseline	814	64.4±2.8	337	64.2±2.6	0.14	0.15	0.94
			Intervention	1040	64.2±2.6	347	64.1±2.6			
		Weight (lbs)	Baseline	810	136±18	334	136±17	0.35	0.25	0.75
			Intervention	1039	136±18	347	135±19			
		BMI (kg/m^2)	Baseline	810	23.1±2.6	334	23.1±2.6	0.88	0.63	0.66
			Intervention	1039	23.1±2.7	347	23.0±2.6			
MP	Men	Age (yrs)	Baseline	764	20.5±3.2	1353	20.6±3.2	0.52	0.44	<0.01
			Intervention	417	20.4±3.6	609	19.2±2.7			
		Height (in)	Baseline	764	70.2±3.0	1353	70.1±2.9	0.86	0.30	0.27
			Intervention	417	69.8±2.7	609	70.0±2.9			
		Weight (lbs)	Baseline	762	173±26	1353	172±27	0.43	0.46	0.01
			Intervention	416	172±27	608	166±25			
		BMI (kg/m^2)	Baseline	726	24.6±3.4	1353	24.6±3.4	0.46	0.65	<0.01
			Intervention	416	24.8±3.4	608	23.9±3.4			
	Women	Age (yrs)	Baseline	236	20.2±2.5	386	20.6±3.0	0.81	0.43	<0.01
			Intervention	145	20.0±2.9	233	19.2±2.1			
		Height (in)	Baseline	235	64.6±2.8	385	64.4±2.8	0.12	0.35	0.75
			Intervention	145	64.8±2.5	233	64.4±2.9			
		Weight (lbs)	Baseline	235	140±18	386	137±19	0.68	0.45	0.26
			Intervention	145	137±21	232	137±19			
		BMI (kg/m^2)	Baseline	235	23.5±2.6	385	23.3±2.6	0.79	0.43	0.08
			Intervention	145	22.8±2.7	232	23.2±2.7			

Type of Unit	Gender	Variable	Phase	MAT		AT		ANOVA p-values		
				N	M±SD	N	M±SD	Group (MAT vs. AT)	Phase (Baseline vs. Intervention)	Group X Phase
ENG	Men	Age (yrs)	Baseline	349	21.0±4.0	1114	21.6±3.8	0.22	0.09	0.27
			Intervention	587	20.0±3.6	818	20.2±3.3			
		Height (in)	Baseline	349	69.7±3.0	1110	69.9±2.9	0.18	0.21	0.65
			Intervention	586	69.9±2.8	817	70.0±2.9			
		Weight (lbs)	Baseline	349	169±25	1111	173±27	0.08	0.19	0.64
			Intervention	585	167±25	816	172±26			
		BMI (kg/m^2)	Baseline	349	24.5±3.3	1109	24.8±3.4	0.11	0.15	0.54
			Intervention	584	24.0±3.2	816	24.6±3.4			
	Women	Age (yrs)	Baseline	14	22.1±4.5	24	22.1±5.8	0.49	0.30	0.64
			Intervention	30	20.5±4.4	19	21.6±4.6			
		Height (in)	Baseline	14	64.9±4.0	24	63.5±2.1	0.11	0.04	0.97
			Intervention	30	65.2±3.9	19	63.9±3.3			
		Weight (lbs)	Baseline	14	135±13	24	134±14	0.75	0.30	0.56
			Intervention	30	137±19	19	141±27			
		BMI (kg/m^2)	Baseline	14	22.7±2.1	24	23.3±2.1	0.25	0.45	0.45
			Intervention	30	22.8±2.3	19	24.2±3.4			
All Training Types	Men	Age (yrs)	Baseline	3861	22.2±4.4	3526	21.7±4.1	0.08	0.03	0.40
			Intervention	3427	20.7±4.1	2413	20.3±3.7			
		Height (in)	Baseline	3851	69.9±3.0	3521	70.0±2.9	0.11	0.60	0.79
			Intervention	3418	69.9±2.9	2407	70.0±2.9			
		Weight (lbs)	Baseline	3849	174±27	3522	173±28	0.32	0.04	0.71
			Intervention	3411	171±28	2407	170±27			
		BMI (kg/m^2)	Baseline	3843	25.0±3.6	3519	24.9±3.5	<0.01	<0.01	0.97
			Intervention	3407	24.5±3.5	2405	24.4±3.5			
	Women	Age (yrs)	Baseline	1068	22.1±4.5	748	21.7±4.2	0.05	0.02	0.81
			Intervention	1218	20.7±4.2	599	20.2±3.8			
		Height (in)	Baseline	1063	64.4±2.8	746	64.3±2.7	0.06	0.10	0.91
			Intervention	1215	64.3±2.6	599	64.2±2.7			
		Weight (lbs)	Baseline	1059	137±18	744	137±18	0.98	0.16	0.74
			Intervention	1214	136±19	598	136±19			
		BMI (kg/m^2)	Baseline	1059	23.2±2.6	743	23.2±2.6	0.15	0.14	0.82
			Intervention	1214	23.1±2.7	598	23.2±2.7			

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; ANOVA=Analysis of Variance; M=mean; SD=standard deviation

7.2 Injury Incidence from the DMSS

Table 4 shows a comparison of cumulative injury incidence (recruits with one or more injuries in training) *between* the MAT and AT groups in the baseline period. Also shown is a comparison of the baseline and intervention periods *within* MAT and AT groups. The injury incidence for each injury index is shown as well as each training type.

Among BCT recruits, there were differences in cumulative injury incidence between the MAT and AT groups in the baseline period with the AT group having a greater injury incidence than the MAT group for all injury indices among both men and

women. Among the men, when the MAT and AT groups were compared to their respective baseline periods, both groups showed a similar reduction in injury incidence in the intervention period. However, among the women, the injury reduction in the intervention period was somewhat larger for the MAT group.

Among male and female MP recruits, there were only small group differences in cumulative injury incidence in the baseline period, although the MAT group tended to have a very slightly greater injury incidence. Among both the men and the women, the AT group had a larger decline in cumulative injury incidence from the baseline to the intervention period compared to the MAT.

Among male and female ENG recruits, there were group differences in cumulative injury incidence in the baseline period with the MAT group having a greater injury incidence than the AT group. Most of the female baseline comparisons were not statistically significant, presumably because of the small sample size (38 women in baseline phase and 49 women in intervention phase). Among the men, injury incidence in the intervention phase was substantially lower than in the baseline phase for both groups, but the differences were greater in the MAT group. The results were similar among the women with a larger decline in the intervention period for the MAT group compared to the AT group. For the AT group, some injury indices (III and TRII) actually showed an increase in injury incidence in the intervention period, but this was due to the very small number of ENG women since an addition of one or two injured women could substantially change the incidence.

When all training groups were combined, there were group differences in the baseline period with the AT group having a greater injury incidence than the MAT group for all injury indices among both men and women. Among the men, the AT group had a greater reduction in injury incidence for all injury indices. Among the women, the MAT and AT groups had similar declines from the baseline to the intervention period but for the III and TRII, the declines were greater for the MAT group. When intervention-period reductions in the CII were calculated relative to their baselines (intervention-baseline/baseline X100%) the number of injured male recruits seen in the clinic/hospital decreased 17% for the MAT group and 22% for the AT group among the men; among female recruits they decreased 22% for the MAT group and 19% for the AT group.

Table 4. Cumulative Injury Incidence by Group, Phase, and Training Type

Training Type	Gender	Injury Index	Group	Cumulative Injury Incidence (%)		Comparison *between* MAT and AT Groups in Baseline Phase		Comparison of Baseline and Intervention Phases *within* MAT or AT Group	
				Baseline	Intervention	Risk Ratio – MAT/AT Baseline Phase (95%CI)	p-value[a]	Risk Ratio- Baseline/ Intervention (95%CI)	p-value[a]
BCT	Men	III	MAT	21.9	18.2	0.59 (0.53-0.65)	<0.01	1.21 (1.08-1.35)	<0.01
			AT	37.3	30.7			1.21 (1.07-1.36)	<0.01
		MIII	MAT	23.5	20.4	0.60 (0.54-0.66)	<0.01	1.15 (1.04-1.27)	<0.01
			AT	39.4	35.4			1.12 (1.00-1.26)	0.05
		OII	MAT	16.8	14.8	0.55 (0.48-0.62)	<0.01	1.14 (1.00-1.29)	0.05
			AT	30.8	25.4			1.21 (1.06-1.40)	<0.01
		TRII	MAT	13.3	12.3	0.55 (0.47-0.63)	<0.01	1.08 (0.94-1.25)	0.29
			AT	24.3	22.1			1.10 (0.94-1.29)	0.24
		CII	MAT	23.6	21.0	0.60 (0.54-0.66)	<0.01	1.12 (1.01-1.24)	0.03
			AT	39.6	34.5			1.15 (1.02-1.29)	0.02
	Women	III	MAT	53.7	41.6	0.83 (0.75-0.91)	<0.01	1.29 (1.17-1.42)	<0.01
			AT	65.1	59.7			1.09 (0.97-1.23)	0.14
		MIII	MAT	56.5	44.9	0.81 (0.74-0.89)	<0.01	1.26 (1.15-1.38)	<0.01
			AT	69.8	60.8			1.15 (1.03-1.28)	0.01
		OII	MAT	48.0	37.6	0.79 (0.71-0.88)	<0.01	1.28 (1.15-1.42)	<0.01
			AT	60.9	53.9			1.13 (0.99-1.29)	0.06
		TRII	MAT	41.6	31.6	0.80 (0.70-0.91)	<0.01	1.31 (1.16-1.48)	<0.01
			AT	52.1	49.9			1.04 (0.90-1.21)	0.56
		CII	MAT	56.1	44.9	0.81 (0.74-0.89)	<0.01	1.25 (1.14-1.37)	<0.01
			AT	69.2	61.1			1.13 (1.02-1.27)	0.03
MP	Men	III	MAT	32.6	24.9	1.09 (0.95-1.24)	0.22	1.31 (1.08-1.59)	<0.01
			AT	30.0	18.1			1.66 (1.38-2.00)	<0.01
		MIII	MAT	35.5	28.3	1.08 (0.96-1.22)	0.22	1.25 (1.05-1.50)	0.01
			AT	32.8	21.7			1.51 (1.28-1.79)	<0.01
		OII	MAT	25.1	22.1	1.07 (0.92-1.25)	0.38	1.14 (0.92-1.42)	0.24
			AT	23.4	14.8			1.58 (1.29-1.96)	<0.01
		TRII	MAT	18.2	17.5	1.02 (0.85-1.23)	0.83	1.04 (0.80-1.34)	0.77
			AT	17.8	11.7			1.53 (1.19-1.96)	<0.1
		CII	MAT	36.1	29.5	1.07 (0.95-1.21)	0.25	1.23 (1.03-1.45)	0.02
			AT	33.6	22.5			1.50 (1.27-1.75)	<0.01
	Women	III	MAT	64.8	53.1	1.05 (0.93-1.19)	0.43	1.22 (1.02-1.46)	0.02
			AT	61.7	39.9			1.54 (1.30-1.84)	<0.01
		MIII	MAT	67.8	56.6	1.04 (0.93-1.16)	0.52	1.20 (1.01-1.42)	0.03
			AT	65.3	42.9			1.52 (1.29-1.79)	<0.01
		OII	MAT	59.3	53.8	1.02 (0.89-1.17)	0.80	1.10 (0.92-1.33)	0.29
			AT	58.3	36.5			1.60 (1.32-1.93)	<0.01
		TRII	MAT	51.3	44.8	1.01 (0.86-1.18)	0.96	1.14 (0.92-1.42)	0.22
			AT	51.0	31.8			1.61 (1.30-1.99)	<0.01
		CII	MAT	69.1	58.6	1.08 (0.96-1.21)	0.20	1.18 (1.00-1.38)	0.04
			AT	64.0	42.5			1.51 (1.27-1.78)	<0.01

Training Type	Gender	Injury Index	Group	Cumulative Injury Incidence (%)		Comparison *between* MAT and AT Groups in Baseline Phase		Comparison of Baseline and Intervention Phases *within* MAT or AT Group	
				Baseline	Intervention	Risk Ratio – MAT/AT Baseline Phase (95%CI)	p-value[a]	Risk Ratio-Baseline/ Intervention (95%CI)	p-value[a]
ENG	Men	III	MAT	49.9	28.8	1.20 (1.06-1.36)	<0.01	1.73 (1.47-2.04)	<0.01
			AT	41.5	26.4			1.57 (1.37-1.80)	<0.01
		MIII	MAT	54.4	30.7	1.27 (1.13-1.42)	<0.01	1.77 (1.52-2.07)	<0.01
			AT	43.0	29.5			1.46 (1.29-1.66)	<0.01
		OII	MAT	43.0	23.3	1.23 (1.06-1.42)	<0.01	1.84 (1.52-2.23)	<0.01
			AT	35.0	21.1			1.66 (1.42-1.93)	<0.01
		TRII	MAT	36.1	19.3	1.27 (1.08-1.51)	<0.01	1.88 (1.51-2.33)	<0.01
			AT	28.4	17.4			1.63 (1.37-1.95)	<0.01
		CII	MAT	53.9	32.5	1.24 (1.10-1.39)	<0.01	1.66 (1.42-1.93)	<0.01
			AT	43.5	30.6			1.44 (1.26-1.61)	<0.01
	Women	III	MAT	78.6	63.3	1.45 (0.92-2.29)	0.13	1.24 (0.84-1.83)	0.31
			AT	54.2	57.9			0.94 (0.55-2.16)	0.81
		MIII	MAT	78.6	63.3	1.35 (0.87-2.08)	0.21	1.24 (0.84-1.83)	0.31
			AT	58.3	57.9			1.01 (0.60-1.68)	0.98
		OII	MAT	78.6	53.3	1.35 (0.87-2.08)	0.21	1.47 (0.96-2.27)	0.11
			AT	58.3	52.6			1.11 (0.64-1.91)	0.71
		TRII	MAT	78.9	46.7	1.71 (1.03-2.87)	0.05	1.68 (1.05-2.70)	0.05
			AT	45.8	57.9			0.79 (0.44-1.41)	0.43
		CII	MAT	78.6	63.3	1.35 (0.87-2.08)	0.21	1.24 (0.84-1.83)	0.32
			AT	58.3	57.9			1.01 (0.60-1.68)	0.98
All	Men	III	MAT	26.6	21.3	0.74 (0.69-0.80)	<0.01	1.25 (1.15-1.36)	<0.01
			AT	35.8	25.5			1.40 (1.29-1.52)	<0.01
		MIII	MAT	28.6	23.7	0.75 (0.71-0.81)	<0.01	1.21 (1.12-1.31)	<0.01
			AT	38.0	29.1			1.31 (1.21-1.41)	<0.01
		OII	MAT	20.8	17.4	0.71 (0.66-0.77)	<0.01	1.19 (1.09-1.31)	<0.01
			AT	29.3	20.6			1.42 (1.30-1.56)	<0.01
		TRII	MAT	16.3	14.4	0.71 (0.64-0.78)	<0.01	1.14 (1.02-1.27)	0.02
			AT	23.1	17.8			1.30 (1.17-1.44)	<0.01
		CII	MAT	28.8	24.0	0.75 (0.70-0.80)	<0.01	1.20 (1.11-1.29)	<0.01
			AT	38.5	30.0			1.28 (1.19-1.38)	<0.01
	Women	III	MAT	56.5	43.8	0.90 (0.83-0.97)	<0.01	1.29 (1.19-1.40)	<0.01
			AT	63.0	51.9			1.21 (1.10-1.33)	<0.01
		MIII	MAT	59.3	47.1	0.88 (0.82-0.95)	<0.01	1.26 (1.16-1.36)	<0.01
			AT	67.1	53.8			1.25 (1.14-1.37)	<0.01
		OII	MAT	50.9	40.1	0.86 (0.79-0.93)	<0.01	1.27 (1.16-1.39)	<0.01
			AT	59.5	47.1			1.26 (1.14-1.40)	<0.01
		TRII	MAT	44.2	33.7	0.86 (0.78-0.95)	<0.01	1.31 (1.18-1.45)	<0.01
			AT	51.3	43.1			1.19 (1.06-1.34)	<0.01
		CII	MAT	59.3	46.5	0.90 (0.83-0.96)	<0.01	1.28 (1.19-1.38)	<0.01
			AT	66.2	53.8			1.23 (1.13-1.35)	<0.01

Abbreviations: III=Installation Injury Index; MIII=Modified Installation Injury Index; OII=Overuse Injury Index; TRII=Training-Related Injury Index; CII=Comprehensive Injury Index; BCT=Basic Combat Training; MP=military police training; ENG=engineer training; CI=confidence interval; MAT=musculoskeletal action team group; AT=athletic trainer group

[a]Chi-square statistic

Because of differences in baseline injury incidence, the MAT and AT groups were analyzed separately in the Cox regression analyses so the groups could be compared to their respective baselines. Table 5shows the results of the univariate Cox regression for the BCT MAT group. Compared to the baseline period, injury risk was lower in the intervention period for both men and women. For both men and women, injury risk was higher among those who were older, had smoked at least 100 cigarettes in their lives, had started smoking earlier in their lives, had smoked in the 30 days before BCT, had rated themselves as less physically active compared to their peers, had a lower frequency of sports, exercise or running in the two months before BCT, had a shorter history of running or weight training, and had a prior lower limb injury especially if that lower limb injury had restricted activity for a ≥1 one week or if they had not fully recovered from that injury. In addition, men were at higher injury risk if they had very low or very high BMI or had a lower frequency of weight training. Women tended to be at higher injury risk if they had lower BMI, no menstrual cycles in the last year, had gone ≥6 months without a menstrual cycle, had taken birth control pills in the last month, or had been pregnant over one year ago.

Table 5. Univariate Cox Regression Analysis among BCT MAT Group

Variable	Strata	Men			Women		
		N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Phase	Baseline	2747	1.00	Referent	818	1.00	Referent
	Intervention	2418	0.84 (0.74-0.95)	<0.01	1042	0.62 (0.53-0.72)	<0.01
Age	<20.0 years	2108	1.00	Referent	884	1.00	Referent
	20.0-24.9	2079	1.18 (1.03-1.34)	0.01	659	1.08 0.94-1.25)	0.27
	25.0-29.9	595	1.19 (0.98-1.44)	0.08	183	1.07 (0.85-1.35)	0.55
	≥30.0	383	1.77 (1.45-2.17)	<0.01	134	1.67 (1.32-2.11)	<0.01
Body Mass Index	<18.5 kg/m^2	103	1.53 (1.05-2.23)	0.03	70	1.28 (0.94-1.76)	0.12
	18.5-24.9	2593	1.00	Referent	1302	1.00	Referent
	25.0-29.9	1961	1.20 (1.05-1.35)	0.01	465	0.99 (0.85-1.16)	0.93
	≥30	478	1.52 (1.26-1.83)	<0.01	11	1.03 (0.46-2.31)	0.94
Smoked 100 Cigarettes in Life	No	3409	1.00	Referent	1400	1.00	Referent
	Yes	1753	1.38 (1.23-1.56)	<0.01	457	1.48 (1.29-1.71)	<0.01
Age Started Smoking	Never	2599	1.00	Referent	116	1.00	Referent
	<13 years	237	1.96 (1.55-2.46)	<0.01	77	1.69 (1.25-2.27)	<0.01
	13-16	1386	1.29 (1.12-147)	<0.01	375	1.34 (1.14-1.57)	<0.01
	≥17	943	1.19 (1.02-1.40)	0.03	247	1.35 (1.12-1.63)	<0.01
Days Smoked 30 Days Before BT	None	3774	1.00	Referent	1463	1.00	Referent
	1-9 days	358	1.45 (1.17-1.78)	<0.01	114	1.31(1.02-1.68)	0.04
	10-19	253	1.32 (1.02-1.70)	0.03	60	1.45 (1.03-2.04)	0.03
	≥20	775	1.61 (1.39-1.86)	<0.01	221	1.48 (1.23-1.79)	<0.01
Cigarettes Smoked in 30 Days Before BT	None	3794	1.00	Referent	1473	1.00	Referent
	1-9 cig/day	850	1.41 (1.22-1.63)	<0.01	245	1.26 (1.05-1.52)	<0.01
	10-19	351	1.62 (1.32-1.98)	<0.01	107	1.71 (1.34-2.19)	<0.01
	≥20	168	1.83 (1.39-2.40)	<0.01	34	2.01 (1.36-2.97)	<0.01
Days of Smokeless Tobacco Use	None	4570	1.00	Referent	1821	1.00	Referent
	1-9 days	172	0.95 (0.69-1.32)	0.77	16	1.31 (0.68-2.51)	0.43
	10-19	107	1.10 (0.76-1.62)	0.60	8	1.76 (0.79-3.93)	0.17
	≥20	314	0.72 (0.54-0.95)	0.02	14	1.20 (0.57-2.52)	0.63

Variable	Strata	Men			Women		
		N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Amount of Smokeless Tobacco Use	None	4560	1.00	Referent	1824	1.00	Referent
	≤3/4 cans,plugs	361	0.90 (0.71-1.14)	0.38	25	1.55 (0.93-2.58)	0.09
	1 to 1-3/4	196	0.71 (0.50-1.01)	0.05	8	1.71 (0.77-3.81)	0.19
	≥2	46	1.11 (0.63-1.96)	0.72	3	0.70 (0.10-4.96)	0.72
Physical Activity Before BT Compared to Peers	Much Less Active	301	2.84 (2.21-3.66)	<0.01	255	2.15 (1.63-2.85)	<0.01
	Less Active	954	1.98 (1.60-2.43)	<0.01	449	1.47 (1.12-1.92)	<0.01
	Average	1305	1.75 (1.43-2.14)	<0.01	493	1.38 (1.06-1.80)	0.02
	More Active	1741	1.22 (0.99-1.49)	0.06	477	1.27 (0.7-1.66)	0.09
	Much More Active	858	1.00	Referent	183	1.00	Referent
Exercise or Sports Frequency 2 Months Before BT	≤1 time/wk	699	2.11 (1.77-2.51)	<0.01	382	1.55 (1.28-1.89)	<0.01
	2-4	2814	1.39 (1.22-1.60)	<0.01	1016	1.29 (1.10-1.52)	<0.01
	≤5	1648	1.00	Referent	460	1.00	Referent
Running/Jogging Frequency 2 Months before BT	≤1 time/wk	1448	1.56 (1.30-1.88)	<0.01	628	1.48 (1.19-1.83)	<0.01
	2-4	2908	1.01 (0.85-1.20)	0.93	978	1.16 (0.94-1.43)	0.18
	≤5	795	1.00	Referent	245	1.00	Referent
Running/Jogging Time 2 Months before BT	≤1 month	1542	1.63 (1.35-1.97)	<0.01	621	1.78 (1.43-2.23)	<0.01
	2-6	2815	1.17 (0.98-1.41)	0.09	970	1.48 (1.20-1.84)	<0.01
	≤7	797	1.00	Referent	266	1.00	Referent
Weight Training Frequency 2 Months before BT	≤1 time/wk	2152	1.46 (1.22-1.75)	<0.01	1016	1.10 (0.84-1.43)	0.49
	2-4	2193	1.20 (0.99-1.44)	0.06	714	0.89 (0.67-1.17)	0.39
	≤5	811	1.00	Referent	124	1.00	Referent
Weight Training Time 2 Months before BT	≤1 month	2239	1.42 (1.22-1.66)	<0.01	1102	1.50 (1.18-1.89)	<0.01
	2-6	1663	1.14 (0.97-1.35)	0.11	554	1.26 (0.98-1.62)	0.07
	≤7	1260	1.00	Referent	199	1.00	Referent
Prior Lower Limb Injury	No	3969	1.00	Referent	1456	1.00	Referent
	Yes	1193	1.34 (1.19-1.53)	<0.01	404	1.22 (1.05-1.42)	<0.01
Prior Injury Prevent Activities ≥1 Week	No Prior Injury	3969	1.00	Referent	1456	1.00	Referent
	No	447	1.16 (0.95-1.42)	0.14	140	1.16 (0.91-1.47)	0.24
	Yes	739	1.46 (1.26-1.70)	<0.01	261	1.27 (1.06-1.52)	<0.01
Totally Recovered from Prior Injury	No Prior Injury	3965	1.00	Referent	1457	1.00	Referent
	No	64	3.42 (2.42-4.81)	<0.01	36	2.35 (1.58-3.51)	<0.01
	Yes	1119	1.26 (1.10-1.44)	<0.01	363	1.15 (0.98-1.35)	0.09
Age at Menarche	No Menses Yet				13	1.31 (0.65-2.63)	0.45
	6-10 years				163	1.08 (0.86-1.35)	0.50
	11-14				1477	1.00	Referent
	15-17				207	0.99 (0.80-1.21)	0.90
Menstrual Cycles in Last Year	No Cycles				55	1.68 (1.21-2.34)	<0.01
	1-9 cycles				308	1.14 (0.96-1.36)	0.14
	10-12				1374	1.00	Referent
	≥13				86	1.13 (0.84-1.52)	0.44
Gone ≥6 Months without Menstrual Cycle	No				1574	1.00	Referent
	Yes				126	1.43 (1.13-1.80)	<0.01
	No Menses Yet				13	1.33 (0.66-2.67)	0.42
Taken Birth Control Pills in Last 12 Months	No				1094	1.00	Referent
	Yes				743	1.15 (1.00-1.31)	0.04
Time Since Last Pregnancy	Never				1509	1.00	Referent
	1-12 Months Ago				67	1.23 (0.88-1.71)	0.23
	≥13				284	1.34 (1.13-1.58)	<0.01

Abbreviations: CI=confidence interval; BT=basic training

Table 6 shows the results of the univariate Cox regression for the BCT AT group. Results were similar to that of the BCT MAT group. Compared to the baseline

period, injury risk was lower in the intervention period for both men and women. For both men and women, injury risk was higher among those who were older, had smoked at least 100 cigarettes in their lives, had smoked in the 30 days before BCT, had rated themselves as less physically active compared to their peers, had a lower frequency of sports, exercise, or running in the two months before BCT, had a shorter history of running, had a shorter history of weight training, and had a prior lower limb injury, especially if that lower limb injury had restricted activity for a ≥ 1 week or if they had not fully recovered from that injury. In addition, men were at higher injury risk if they had a lower frequency of weight training and women tended to be at higher injury risk if they had no menstrual cycles in the last year, had gone ≥6 months without a menstrual cycle, had taken birth control pills in the last month, or had ever been pregnant.

Table 6. Univariate Cox Regression Analysis among BCT AT Group

Variable	Strata	Men			Women		
		N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Phase	Baseline	1059	1.00	Referent	338	1.00	Referent
	Intervention	985	0.81 (0.70-0.95)	<0.01	346	0.78 (0.63-1.01)	0.05
Age	<20.0 years	795	1.00	Referent	309	1.00	Referent
	20.0-24.9	832	0.97 (0.82-1.14)	0.67	254	1.19 (0.97-1.46)	0.09
	25.0-29.9	250	1.19 (0.95-1.50)	0.13	70	0.91 (0.65-1.28)	0.58
	≥30.0	167	1.43 (1.11-1.83)	<0.01	51	1.55 (1.00-1.58)	0.05
Body Mass Index	<18.5 kg/m^2	35	1.06 (0.61-1.84)	0.85	20	1.05 (0.60-1.82)	0.87
	18.5-24.9	1048	1.00	Referent	478	1.00	Referent
	25.0-29.9	751	1.10 (0.94-1.28)	0.23	182	1.06 (0.86-1.30)	0.60
	≥30	203	1.17 (0.92-1.48)	0.21	0	-----	
Smoked 100 Cigarettes in Life	No	1386	1.00	Referent	501	1.00	Referent
	Yes	655	1.45 (1.26-1.68)	<0.01	182	1.44 (1.18-1.77)	<0.01
Age Started Smoking	Never	1058	1.00	Referent	416	1.00	Referent
	<13 years	102	1.62 (1.20-2.19)	<0.01	28	1.50 (0.96-2.35)	0.07
	13-16	498	1.30 (1.10-1.55)	<0.01	153	1.15 (0.92-1.45)	0.22
	≥17	386	1.25 (1.03-1.51)	0.02	87	1.20 (0.90-1.59)	0.21
Days Smoked 30 Days Before BT	None	1500	1.00	Referent	535	1.00	Referent
	1-9 days	155	1.21 (0.94-1.58)	0.15	38	1.15 (0.77-1.73)	0.50
	10-19	78	0.93 (0.62-1.37)	0.70	22	2.04 (1.29-3.25)	<0.01
	≥20	308	1.60 (1.34-1.92)	<0.01	89	1.55 (1.19-2.01)	<0.01
Cigarettes Smoked in 30 Days Before BT	None	1505	1.00	Referent	537	1.00	Referent
	1-9 cig/day	340	1.26 (1.04-1.51)	0.02	100	1.39 (1.08-1.79)	0.01
	10-19	137	1.68 (1.31-2.16)	<0.01	35	1.69 (1.15-2.49)	<0.01
	≥20	60	1.50 (1.03-2.19)	0.04	11	3.70 (2.02-6.78)	<0.01
Days of Smokeless Tobacco Use	None	1799	1.00	Referent	674	1.00	Referent
	1-9 days	59	1.25 (0.85-1.84)	0.25	7	1.37 (0.57-3.32)	0.48
	10-19	48	1.22 (0.79-1.88)	0.38	0	-----	-----
	≥20	138	1.03 (0.78-1.37)	0.83	3	0.48 (0.07-3.38)	0.46
Amount of Smokeless Tobacco Use	None	1801	1.00	Referent	673	1.00	Referent
	≤3/4 cans,plugs	159	0.86 (0.65-1.14)	0.29	8	0.70 (0.26-1.86)	0.47
	1 to 1-3/4	64	1.45 (1.01-2.07)	0.04	2	0.94 (0.13-6.70)	0.95
	≥2	19	1.57 (0.84-2.93)	0.16	0	-----	-----

Variable	Strata	Men			Women		
		N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Activity Before BT Compared to Peers	Much Less Active	98	1.82 (1.27-2.61)	<0.01	105	2.85 (1.87-4.36)	<0.01
	Less Active	383	1.77 (1.38-2.28)	<0.01	175	2.57 (1.72-3.85)	<0.01
	Average	534	1.47 (1.15-1.87)	<0.01	165	2.18 (1.45-3.28)	<0.01
	More Active	691	1.21 (0.95-1.54)	0.12	173	1.34 (0.88-2.03)	0.17
	Much More Active	326	1.00	Referent	66	1.00	Referent
Exercise or Sports Frequency 2 Months Before BT	≤1 time/wk	236	1.77 (1.40-2.23)	<0.01	156	1.75 (1.32-2.33)	<0.01
	2-4	1167	1.29 (1.09-1.53)	<0.01	372	1.47 (1.14-1.88)	<0.01
	≤5	628	1.00	Referent	152	1.00	Referent
Running/Jogging Frequency 2 Months before BT	≤1 time/wk	532	1.79 (1.39-2.29)	<0.01	256	1.79 (1.30-2.47)	<0.01
	2-4	1228	1.20 (0.94-1.52)	0.14	340	1.37 (1.00-1.87)	0.05
	≤5	275	1.00	Referent	88	1.00	Referent
Running/Jogging Time 2 Months before BT	≤1 month	572	2.12 (1.65-2.72)	<0.01	249	1.97 (1.42-2.74)	<0.01
	2-6	1160	1.48 (1.16-1.89)	<0.01	339	1.63 (1.18-2.25)	<0.01
	≤7	305	1.00	Referent	93	1.00	Referent
Weight Training Frequency 2 Months before BT	≤1 time/wk	837	1.33 (1.06-1.66)	0.01	398	1.16 (0.80-1.68)	0.45
	2-4	892	1.13 (0.90-1.42)	0.28	235	0.81 (0.55-1.19)	0.29
	≤5	308	1.00	Referent	47	1.00	Referent
Weight Training Time 2 Months before BT	≤1 month	899	1.60 (1.31-1.95)	<0.01	426	1.77 (1.27-2.47)	<0.01
	2-6	667	1.50 (1.22-1.85)	<0.01	179	1.46 (1.01-2.10)	0.04
	≤7	474	1.00	Referent	79	1.00	Referent
Prior Lower Limb Injury	No	1586	1.00	Referent	557	1.00	Referent
	Yes	452	1.33 (1.13-1.56)	<0.01	126	1.27 (1.01-1.60)	0.05
Prior Injury Prevent Activities ≥1 Week	No Prior Injury	1586	1.00	Referent	557	1.00	Referent
	No	161	1.19 (0.92-1.54)	0.19	41	1.12 (0.76-1.66)	0.56
	Yes	290	1.40 (1.16-1.70)	<0.01	85	1.35 (1.03-1.77)	0.03
Totally Recovered from Prior Injury	No Prior Injury	1582	1.00	Referent	557	1.00	Referent
	No	31	2.18 (1.36-3.49)	<0.01	14	2.44 (1.37-4.34)	<0.01
	Yes	415	1.27 (1.07-1.50)	<0.01	111	1.20 (0.94-1.54)	0.15
Age at Menarche	No Menses Yet				1	-----	-----
	6-10 years				66	1.07 (0.78-1.47)	0.68
	11-14				539	1.00	Referent
	15-17				78	1.11 (0.83-1.49)	0.50
Menstrual Cycles in Last Year	No Cycles				29	2.05 (1.37-3.08)	<0.01
	1-9 cycles				87	1.07 (0.81-1.42)	0.64
	10-12				537	1.00	Referent
	≥13				20	1.17 (0.68-1.99)	0.57
Gone ≥6 Months without Menstrual Cycle	No				591	1.00	Referent
	Yes				49	1.55 (1.10-2.17)	0.04
	No Menses Yet				1	-----	-----
Taken Birth Control Pills in Last 12 Months	No				409	1.00	Referent
	Yes				271	1.38 (1.14-1.66)	<0.01
Time Since Last Pregnancy	Never				575	1.00	Referent
	1-12 Months Ago				9	2.34 (1.16-4.72)	0.02
	≥13				100	1.35 (1.05-1.74)	0.02

Abbreviations: CI=confidence interval; BT=basic training

Table 7 shows the results of the univariate Cox regression for the MP MAT group. Compared to the baseline period, injury risk was lower in the intervention period for both men and women. For both men and women, injury risk was higher among those who had smoked at least 100 cigarettes in their lives, had smoked in the 30 days before BCT, had rated themselves as less physically active compared to their

peers, had a shorter history of running, and had a prior lower limb injury. Men were at higher injury risk if they had a shorter history of weight training or had a lower limb injury that prevented activity for ≥ 1 week, even if they reported that they had totally recovered from that injury. Women tended to be at higher injury risk if they had a lower frequency of running in the two months before training, reported a prior injury that they had not recovered from, had later menarche age, and had no or few menstrual cycles in the last year.

Table 7. Univariate Cox Regression Analysis among MP MAT Group

Variable		Men			Women		
	Strata	N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Phase	Baseline	764	1.00	Referent	236	1.00	Referent
	Intervention	417	0.78 (0.62-0.97)	<0.01	145	0.75 (0.55-0.98)	<0.01
Age	<20.0 years	705	1.00	Referent	236	1.00	Referent
	20.0-24.9	378	1.19 (0.96-1.47)	0.11	129	1.15 (0.88-1.50)	0.30
	25.0-29.9	65	1.10 (0.71-1.70)	0.68	10	0.78 (0.32-1.89)	0.58
	≥30.0	33	1.56 (0.92-2.63)	0.10	6	1.88 (0.77-4.60)	0.16
Body Mass Index	<18.5 kg/m^2	18	0.70 (0.23-1.64)	0.33	14	0.76 (0.37-1.54)	0.45
	18.5-24.9	637	1.00	Referent	264	1.00	Referent
	25.0-29.9	442	1.14 (0.93-1.40)	0.22	100	0.98 (0.74-1.30)	0.89
	≥30	81	1.02 (0.69-1.53)	0.91	2	0.70 (0.10-4.99)	0.72
Smoked 100 Cigarettes in Life	No	821	1.00	Referent	269	1.00	Referent
	Yes	360	1.44 (1.18-1.77)	<0.01	112	1.29 (0.99-1.68)	0.07
Age Started Smoking	Never	623	1.00	Referent	220	1.00	Referent
	<13 years	36	1.53 (0.91-2.58)	0.11	16	1.59 (0.90-2.81)	0.11
	13-16	324	1.18 (0.94-1.48)	0.16	84	0.95 (0.69-1.31)	0.75
	≥17	198	1.09 (0.82-1.43)	0.53	61	1.29 (0.92-1.81)	0.14
Days Smoked 30 Days Before BT	None	882	1.00	Referent	289	1.00	Referent
	1-9 days	65	1.11 (0.72-1.71)	0.65	23	1.72 (1.06-2.79)	0.03
	10-19	60	0.84 (0.51-1.36)	0.47	13	1.06 (0.52-2.15)	0.87
	≥20	174	1.41 (1.09-1.82)	<0.01	56	1.30 (0.93-1.82)	0.13
Cigarettes Smoked in 30 Days Before BT	None	884	1.00	Referent	289	1.00	Referent
	1-9 cig/day	172	1.24 (0.95-1.61)	0.12	59	1.30 (0.93-1.82)	0.13
	10-19	86	1.06 (0.72-1.55)	0.77	21	1.18 (0.68-2.03)	0.55
	≥20	39	1.67 (1.04-2.69)	0.04	12	2.06 (1.12-3.78)	<0.01
Days of Smokeless Tobacco Use	None	942	1.00	Referent	372	1.00	Referent
	1-9 days	46	1.15 (0.71-1.85)	0.57	4	1.37 (0.51-3.69)	0.53
	10-19	35	0.97 (0.53-1.76)	0.91	1	0.99 (0.14-7.09)	0.99
	≥20	158	0.98 (0.73-1.31)	0.86	4	1.33 (0.43-4.14)	0.63
Amount of Smokeless Tobacco Use	None	951	1.00	Referent	373	1.00	Referent
	≤3/4 cans,plugs	66	1.10 (0.72-1.68)	0.67	1	2.66 (0.37-19.01)	0.33
	1 to 1-3/4	115	1.09 (0.79-1.50)	0.61	5	1.12 (0.42-3.02)	0.82
	≥2	46	1.06 (0.64-1.75)	0.83	2	1.17 (0.29-4.71)	0.83
Activity Before BT Compared to Peers	Much Less Active	51	1.45 (0.89-2.36)	0.13	29	1.91 (1.00-3.65)	0.05
	Less Active	181	1.61 (1.16-2.23)	<0.01	95	1.80 (1.06-3.06)	0.03
	Average	314	1.11 (0.82-1.52)	0.50	122	1.51 (0.90-2.55)	0.12
	More Active	440	0.80 (0.59-1.08)	0.15	102	1.17 (0.69-2.00)	0.57
	Much More Active	195	1.00	Referent	33	1.00	Referent
Exercise or Sports Frequency 2 Months Before BT	≤1 time/wk	116	1.35 (0.97-1.87)	0.07	56	1.31 (0.87-1.97)	0.20
	2-4	623	0.97 (0.79-1.20)	0.79	223	1.40 (1.04-1.90)	0.03
	≤5	442	1.00	Referent	102	1.00	Referent

Variable		Men			Women		
	Strata	N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Running/ Jogging Frequency 2 Months before BT	≤1 time/wk	289	1.12 (0.81-1.55)	0.48	112	1.56 (1.01-2.42)	0.05
	2-4	726	0.92 (0.69-1.23)	0.56	220	1.34 (0.89-2.02)	0.17
	≤5	165	1.00	Referent	49	1.00	Referent
Running/ Jogging Time 2 Months before BT	≤1 month	285	1.39 (1.04-1.85)	0.02	105	1.84 (1.24-2.74)	<0.01
	2-6	625	1.15 (0.89-1.48)	0.30	204	1.60 (1.11-2.31)	0.01
	≤7	271	1.00	Referent	72	1.00	Referent
Weight Training Frequency 2 Months before BT	≤1 time/wk	439	1.19 (0.91-1.57)	0.21	200	0.86 (0.54-1.36)	0.52
	2-4	524	0.89 (0.68-1.18)	0.42	152	0.71 (0.44-1.14)	0.16
	≤5	217	1.00	Referent	29	1.00	Referent
Weight Training Time 2 Months before BT	≤1 month	440	1.46 (1.15-1.86)	<0.01	195	1.36 (0.91-2.04)	0.13
	2-6	360	1.27 (0.98-1.64)	0.08	133	1.30 (0.85-1.98)	0.22
	≤7	380	1.00	Referent	52	1.00	Referent
Prior Lower Limb Injury	No	906	1.00	Referent	293	1.00	Referent
	Yes	274	1.38 (1.11-1.71)	<0.01	88	1.34 (1.01-1.78)	0.04
Prior Injury Prevent Activities ≥1 Week	No Prior Injury	906	1.00	Referent	293	1.00	Referent
	No	99	1.28 (0.91-1.79)	0.16	25	1.51 (0.96-2.37)	0.08
	Yes	174	1.42 (1.09-1.83)	<0.01	63	1.28 (0.92-1.77)	0.14
Totally Recovered from Prior Injury	No Prior Injury	906	1.00	Referent	293	1.00	Referent
	No	17	1.24 (0.55-2.79)	0.60	13	2.59 (1.47-4.56)	<0.01
	Yes	257	1.38 (1.11-1.73)	<0.01	75	1.20 (0.89-1.63)	0.24
Age at Menarche	No Menses Yet				0	-----	-----
	6-10 years				33	0.93 (0.58-1.49)	0.77
	11-14				298	1.00	Referent
	15-17				50	1.41 (1.00-2.00)	0.05
Menstrual Cycles in Last Year	No Cycles				11	1.86 (1.03-3.34)	0.04
	1-9 cycles				87	1.57 (1.18-2.09)	<0.01
	10-12				264	1.00	Referent
	≥13				15	1.13 (0.56-2.30)	0.73
Gone ≥6 Months without Menstrual Cycle	No				330	1.00	Referent
	Yes				27	1.43 (0.92-2.22)	0.11
	No Menses Yet				0	-----	-----
Taken Birth Control Pills in Last 12 Months	No				207	1.00	Referent
	Yes				174	1.13 (0.88-1.45)	0.34
Time Since Last Pregnancy	Never				344	1.00	Referent
	1-12 Months Ago				9	0.65 (0.24-1.74)	0.39
	≥13				28	1.08 (0.67-1.75)	0.75

Abbreviations: CI=confidence interval; BT=basic training

Table 8 shows the results of the univariate Cox regression for the MP AT group. Compared to the baseline period, injury risk was lower in the intervention period for both men and women. For both men and women, injury risk was higher among those who were older, had smoked at least 100 cigarettes in their lives, had rated themselves as less physically active compared to their peers, a lower frequency of exercise or sport in the 2 months before training, and had a shorter history of running or weight training. In addition, men were at higher injury risk if they had started smoking at a younger age, had smoked in the 30 days before training, or had not fully recovered from a prior lower limb injury. Women were at higher injury risk if they had a lower frequency of running in the two months before training, had ≥13 menstrual cycles in the last year, had taken birth control pills in the last year, or had

been pregnant over a year ago.

Table 8. Univariate Cox Regression Analysis among MP AT Group

Variable		Men			Women		
	Strata	N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Phase	Baseline	1353	1.00	Referent	386	1.00	Referent
	Intervention	609	0.60 (0.49-0.74)	<0.01	233	0.59 (0.46-0.76)	<0.01
Age	<20.0 years	1249	1.00	Referent	378	1.00	Referent
	20.0-24.9	590	1.32 (1.11-1.57)	<0.01	206	1.12 (0.90-1.41)	0.31
	25.0-29.9	86	1.33 (0.91-1.94)	0.15	27	1.14 (0.69-1.90)	0.61
	≥30.0	37	2.05 (1.28-3.29)	<0.01	8	2.46 (1.09-5.55)	0.03
Body Mass Index	<18.5 kg/m^2	33	1.33 (0.75-2.37)	0.33	18	0.91 (0.48-1.71)	0.77
	18.5-24.9	1156	1.00	Referent	433	1.00	Referent
	25.0-29.9	640	1.09 (0.91-1.29)	0.36	162	0.88 (0.69-1.12)	0.31
	≥30	132	1.30 (0.96-1.76)	0.09	4	0.86 (0.22-3.47)	0.84
Smoked 100 Cigarettes in Life	No	1430	1.00	Referent	476	1.00	Referent
	Yes	530	1.42 (1.19-1.68)	<0.01	143	1.23 (0.97-1.57)	0.09
Age Started Smoking	Never	1079	1.00	Referent	380	1.00	Referent
	<13 years	74	1.61 (1.11-2.34)	0.01	20	1.43 (0.80-2.55)	0.23
	13-16	491	1.37 (1.14-1.65)	<0.01	138	1.18 (0.92-1.52)	0.20
	≥17	318	0.96 (0.76-1.23)	0.77	81	1.14 (0.83-1.57)	0.42
Days Smoked 30 Days Before BT	None	1511	1.00	Referent	500	1.00	Referent
	1-9 days	128	1.11 (0.80-1.54)	0.53	19	1.32 (0.76-2.31)	0.32
	10-19	66	1.11 (0.72-1.72)	0.63	14	0.89 (0.42-1.87)	0.75
	≥20	256	1.63 (1.32-2.01)	<0.01	86	1.28 (0.96-1.71)	0.10
Cigarettes Smoked in 30 Days Before BT	None	1513	1.00	Referent	500	1.00	Referent
	1-9 cig/day	275	1.19 (0.94-1.49)	0.14	73	1.15 (0.84-1.58)	0.37
	10-19	122	1.54 (1.15-2.08)	<0.01	32	1.28 (0.81-2.04)	0.29
	≥20	51	2.50 (1.72-3.64)	<0.01	14	1.62 (0.86-3.05)	0.13
Days of Smokeless Tobacco Use	None	1620	1.00	Referent	587	1.00	Referent
	1-9 days	72	1.57 (1.09-2.25)	0.02	8	0.34 (0.08-1.35)	0.13
	10-19	60	0.93 (0.57-1.51)	0.77	7	1.27 (0.52-3.07)	0.60
	≥20	210	1.05 (0.81-1.37)	0.70	7	0.79 (0.25-2.47)	0.69
Amount of Smokeless Tobacco Use	None	1629	1.00	Referent	599	1.00	Referent
	≤3/4 cans,plugs	131	1.04 (0.75-1.44)	0.82	14	0.69 (0.31-1.56)	0.38
	1 to 1-3/4	152	1.15 (0.87-1.54)	0.33	5	1.60 (0.60-4.29)	0.35
	≥2	46	1.59 (1.02-2.49)	0.04	1	-----	-----
Activity Before BT Compared to Peers	Much Less Active	95	1.92 (1.33-2.78)	<0.01	66	1.50 (0.96-2.33)	0.07
	Less Active	232	1.68 (1.28-2.20)	<0.01	142	1.57 (1.07-2.30)	0.02
	Average	482	1.35 (1.04-1.75)	0.02	160	0.99 (0.67-1.46)	0.95
	More Active	688	1.10 (0.86-1.41)	0.45	181	1.02 (0.70-1.50)	0.91
	Much More Active	374	1.00	Referent	70	1.00	Referent
Exercise or Sports Frequency 2 Months Before BT	≤1 time/wk	206	1.63 (1.27-2.10)	<0.01	102	1.63 (1.18-2.24)	<0.01
	2-4	1002	1.10 (0.92-1.31)	0.30	336	1.29 (1.00-1.66)	0.05
	≤5	750	1.00	Referent	181	1.00	Referent
Running/ Jogging Frequency 2 Months before BT	≤1 time/wk	503	1.05 (0.81-1.37)	0.70	195	1.59 (1.13-2.24)	<0.01
	2-4	1181	0.90 (0.71-1.14)	0.38	327	1.29 (0.93-1.79)	0.12
	≤5	276	1.00	Referent	97	1.00	Referent
Running/ Jogging Time 2 Months before BT	≤1 month	459	1.46 (1.16-1.85)	<0.01	168	2.01 (1.41-2.87)	<0.01
	2-6	1044	1.12 (0.90-1.38)	0.31	328	2.21 (1.59-3.06)	<0.01
	≤7	458	1.00	Referent	121	1.00	Referent
Weight Training Frequency 2 Months before BT	≤1 time/wk	686	1.17 (0.94-1.47)	0.16	323	1.36 (0.91-2.02)	0.13
	2-4	903	0.93 (0.74-1.16)	0.49	240	1.13 (0.75-1.71)	0.55
	≤5	373	1.00	Referent	56	1.00	Referent

Variable		Men			Women		
	Strata	N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Weight Training Time 2 Months before BT	≤1 month	689	1.27 (1.05-1.55)	0.01	336	1.75 (1.25-2.46)	<0.01
	2-6	612	1.02 (0.83-1.26)	0.82	187	1.55 (1.07-2.23)	0.02
	≤7	660	1.00	Referent	96	1.00	Referent
Prior Lower Limb Injury	No	144	1.00	Referent	445	1.00	Referent
	Yes	520	1.14 (0.95-1.36)	0.16	174	1.14 (0.91-1.44)	0.26
Prior Injury Prevent Activities ≥1 Week	No Prior Injury	1442	1.00	Referent	445	1.00	Referent
	No	174	1.15 (0.87-1.52)	0.33	118	1.11 (0.76-1.61)	0.58
	Yes	345	1.12 (0.91-1.39)	0.28	56	1.16 (0.89-1.51)	0.28
Totally Recovered from Prior Injury	No Prior Injury	1439	1.00	Referent	445	1.00	Referent
	No	34	2.36 (1.45-3.83)	<0.01	7	1.13 (0.42-3.04)	0.81
	Yes	484	1.07 (0.89-1.29)	0.46	167	1.14 (0.91-1.45)	0.26
Age at Menarche	No Menses Yet				5	0.24 (0.03-1.74)	0.16
	6-10 years				88	1.18 (0.88-1.59)	0.26
	11-14				459	1.00	Referent
	15-17				67	0.81 (0.57-1.17)	0.27
Menstrual Cycles in Last Year	No Cycles				15	1.04 (0.54-2.03)	0.91
	1-9 cycles				106	1.01 (0.75-1.34)	0.97
	10-12				421	1.00	Referent
	≥13				25	1.71 (1.06-2.78)	0.03
Gone ≥6 Months without Menstrual Cycle	No				547	1.00	Referent
	Yes				40	1.26 (0.84-1.89)	0.27
	No Menses Yet				8	0.60 (0.19-1.88)	0.38
Taken Birth Control Pills in Last 12 Months	No				341	1.00	Referent
	Yes				271	1.23 (0.99-1.52)	0.06
Time Since Last Pregnancy	Never				565	1.00	Referent
	1-12 Months Ago				9	1.23 (0.55-2.76)	0.61
	≥13				45	1.71 (1.20-2.46)	<0.01

Abbreviations: CI=confidence interval; BT=basic training

Because of the very small number of female ENGs, the only univariate Cox regression that was performed was that comparing the phases within the MAT and AT groups. Performing univariate Cox regression on the other covariates would have further decreased sample sizes in the covariate cells, and thus further reduced statistical power. For the female ENGs in the MAT group (n=14 in baseline phase, n=30 in intervention phase), injury risk was reduced in the intervention period compared to the baseline period but the difference was not statistically significant (HR (intervention/baseline)=0.64, 95%CI=0.30-1.35, p=0.24). For the female ENGs in the AT group (n=24 in baseline phase, n=19 in intervention phase), injury risk was actually higher in the intervention period compared to the baseline period but the difference was not statistically significant (HR (intervention/baseline)=1.22, 95%CI=0.55-2.68, p=0.63).

Table 9 shows the univariate Cox regression for the male ENGs showing both the MAT and the AT groups in a single table. In both the MAT and AT groups, injury risk was lower in the intervention period compared to the baseline period. Among the male MAT ENGs, injury risk was higher among those who were older, had lower BMI, had started smoking earlier, had rated themselves as less physically active

compared to their peers, had a lower frequency of exercise or sport in the 2 months before training, had a lower frequency or shorter history of running, or had a prior lower limb injury that restricted activity for ≥ 1 week or had not recovered from a prior lower limb injury.

Among the male AT group ENGs, injury risk was higher among those who were older, had very low or very high BMI, had smoked at least 100 cigarettes in their life, had smoked ≥20 cigarettes, had smoked at least 10-19 cigarettes/day in the 30 days before training, had rated themselves as less physically active compared to their peers, had a lower frequency of exercise or sport, had a lower frequency or shorter history of running, had a shorter history of weight training, or had a prior lower limb injury, especially if that injury restricted activity for ≥ 1 week or the recruit had not totally recovered from that injury.

Table 9. Univariate Cox Regression Analysis among ENG MAT and AT Group Men

Variable		MAT Group			AT Group		
	Strata	N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Phase	Baseline	349	1.00	Referent	1114	1.00	Referent
	Intervention	587	0.52 (0.42-0.63)	<0.01	818	0.60 (0.50-0.70)	<0.01
Age	<20.0 years	591	1.00	Referent	927	1.00	Referent
	20.0-24.9	251	1.25 (0.99-1.57)	0.06	787	1.15 (0.98-1.35)	0.08
	25.0-29.9	58	1.52 (1.03-2.25)	0.03	147	1.28 (0.98-1.69)	0.07
	≥30.0	36	1.83 (1.17-2.86)	<0.01	71	2.34 (1.71-3.21)	<0.01
Body Mass Index	<18.5 kg/m^2	14	3.20 (1.74-5.86)	<0.01	33	1.70 (1.05-2.77)	0.03
	18.5-24.9	557	1.00	Referent	1007	1.00	Referent
	25.0-29.9	313	0.90 (0.72-1.12)	0.35	745	0.96 (0.82-1.13)	0.65
	≥30	49	1.10 (0.70-1.72)	0.68	140	1.64 (1.27-2.11)	<0.01
Smoked 100 Cigarettes in Life	No	606	1.00	Referent	1238	1.00	Referent
	Yes	326	1.11 (0.90-1.36)	0.35	694	1.29 (1.11-1.49)	<0.01
Age Started Smoking	Never	444	1.00	Referent	905	1.00	Referent
	<13 years	46	1.51 (0.99-2.29)	0.06	86	1.19 (0.85-1.68)	0.31
	13-16	313	1.05 (0.84-1.32)	0.65	617	1.13 (0.96-1.33)	0.15
	≥17	133	0.84 (0.60-1.15)	0.26	324	0.95 (0.77-1.18)	0.65
Days Smoked 30 Days Before BT	None	636	1.00	Referent	1344	1.00	Referent
	1-9 days	82	0.87 (0.59-1.28)	0.48	182	1.18 (0.93-1.50)	0.18
	10-19	59	1.22 (0.82-1.81)	0.34	101	0.88 (0.62-1.25)	0.48
	≥20	159	1.23 (0.95-1.60)	0.12	305	1.33 (0.10-1.61)	<0.01
Cigarettes Smoked in 30 Days Before BT	None	640	1.00	Referent	1358	1.00	Referent
	1-9 cig/day	191	1.11 (0.87-1.43)	0.40	334	1.07 (0.88-1.30)	0.49
	10-19	73	1.14 (0.78-1.66)	0.51	161	1.40 (1.10-1.78)	<0.01
	≥20	32	1.26 (0.74-2.17)	0.39	77	1.44 91.03-2.02)	0.03
Days of Smokeless Tobacco Use	None	761	1.00	Referent	1577	1.00	Referent
	1-9 days	35	0.74 (0.40-1.34)	0.32	83	0.83 (0.57-1.21)	0.34
	10-19	31	0.96 (0.54-1.71)	0.89	59	1.19 (0.80-1.78)	0.32
	≥20	108	1.00 (0.73-1.37)	0.99	213	0.92 (0.76-1.13)	0.24
Amount of Smokeless Tobacco Use	None	756	1.00	Referent	1583	1.00	Referent
	≤3/4 cans,plugs	103	0.79 (0.56-1.12)	0.19	207	0.76 (0.42-1.34)	0.12
	1 to 1-3/4	61	0.97 (0.64-1.46)	0.87	106	0.91 (0.66-1.25)	0.91
	≥2	15	1.58 (0.78-3.18)	0.20	34	1.45 (0.89-2.34)	0.14

Variable		MAT Group			AT Group		
	Strata	N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Activity Before BT Compared to Peers	Much Less Active	51	1.51 (0.96-2.38)	0.08	75	2.31 (1.61-3.31)	<0.01
	Less Active	177	1.59 (1.15-2.19)	<0.01	335	1.76 (1.37-2.24)	<0.01
	Average	215	1.08 (0.76-1.49)	0.67	489	1.17 (0.92-1.49)	0.21
	More Active	322	0.99 (0.73-1.34)	0.94	698	1.17 (0.93-1.46)	0.19
	Much More Active	169	1.00	Referent	334	1.00	Referent
Exercise or Sports Frequency 2 Months Before BT	≤1 time/wk	101	2.09 (1.53-2.84)	<0.01	205	1.56 (1.23-1.98)	<0.01
	2-4	474	1.27 (1.01-1.59)	0.04	1026	1.23 (1.04-1.44)	0.01
	≤5	358	1.00	Referent	699	1.00	Referent
Running/ Jogging Frequency 2 Months before BT	≤1 time/wk	271	1.40 (1.04-1.90)	0.03	519	1.49 (1.17-1.89)	<0.01
	2-4	507	0.89 (0.67-1.20)	0.44	1108	1.20 (0.96-1.49)	0.12
	≤5	156	1.00	Referent	303	1.00	Referent
Running/ Jogging Time 2 Months before BT	≤1 month	302	1.39 (1.04-1.86)	0.03	512	1.70 (1.34-2.15)	<0.01
	2-6	446	1.10 (0.83-1.47)	0.50	1057	1.49 (1.19-1.85)	<0.01
	≤7	187	1.00	Referent	363	1.00	Referent
Weight Training Frequency 2 Months before BT	≤1 time/wk	383	1.16 (0.88-1.53)	0.30	717	1.19 (0.96-1.47)	0.11
	2-4	373	0.88 (0.66-1.18)	0.39	894	0.91 (0.73-1.12)	0.36
	≤5	176	1.00	Referent	320	1.00	Referent
Weight Training Time 2 Months before BT	≤1 month	395	1.11 (0.87-1.43)	0.41	739	1.41 (1.18-1.70)	<0.01
	2-6	295	1.04 (0.79-1.36)	0.79	656	1.19 (0.98-1.45)	0.08
	≤7	245	1.00	Referent	535	1.00	Referent
Prior Lower Limb Injury	No	732	1.00	Referent	1455	1.00	Referent
	Yes	203	1.19 (0.94-1.51)	0.15	477	1.28 (1.09-1.51)	<0.01
Prior Injury Prevent Activities ≥1 Week	No Prior Injury	732	1.00	Referent	1455	1.00	Referent
	No	70	0.94 (0.63-1.40)	0.76	184	1.07 (0.84-1.37)	0.59
	Yes	133	1.34 (1.02-1.77)	0.03	292	1.42 (1.18-1.72)	<0.01
Totally Recovered from Prior Injury	No Prior Injury	731	1.00	Referent	1451	1.00	Referent
	No	12	1.88 (0.90-3.98)	0.10	19	3.10 (1.79-5.38)	<0.01
	Yes	190	1.16 (0.91-1.49)	0.23	457	1.24 (1.05-1.46)	0.01

Abbreviations: CI=confidence interval; BT=basic training

Table 10 shows the univariate Cox regression for the MAT group for all types of training combined. Among both men and women, injury risk was lower in the intervention period compared to the baseline period. Among both men and women, injury risk was higher among those who were in ENG training, were older, had smoked at least 100 cigarettes in their life, had started smoking earlier in life, had smoked in the 30 days before training, had rated themselves as less physically active compared to their peers, had a lower frequency of exercise or sport in the 2 months before training, had a lower frequency or shorter history of running, had a shorter history of weight training, or had a prior lower limb injury, especially if that injury had restricted activity for ≥ 1 week or the recruit had not recovered from that injury. In addition, men were at higher injury risk if they had very low or very high BMI or a lower frequency of weight training. Women were at higher risk if they had no menstrual cycles in the last year or 1-9 cycles in the last year, had gone ≥ 6 months without a menstrual cycle, had used birth control pills in the last year, or had been pregnant over 1 year ago.

Table 10. Univariate Cox Regression for MAT Group for All Types of Training Combined

Variable	Strata	Men			Women		
		N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Phase	Baseline	3860	1.00	Referent	1068	1.00	Referent
	Intervention	3422	0.83 (0.76-0.91)	<0.01	1217	0.74 (0.67-0.83)	<0.01
Training Type	BCT	5165	1.00	Referent	1861	1.00	Referent
	MP	1181	1.06 (0.94-1.20)	0.35	380	1.01 (0.87-1.18)	0.89
	ENG	936	1.63 (1.44-1.83)	<0.01	44	1.40 (0.97-2.02)	0.07
Age	<20.0 years	3404	1.00	Referent	1146	1.00	Referent
	20.0-24.9	2708	1.13 (1.03-1.25)	0.01	798	1.10 (0.97-1.24)	0.13
	25.0-29.9	718	1.14 (0.97-1.34)	0.10	198	1.05 (0.85-1.30)	0.67
	≥30.0	452	1.65 (1.39-1.95)	<0.01	143	1.69 (1.36-2.10)	<0.01
Body Mass Index	<18.5 kg/m^2	135	1.44 (1.07-1.95)	0.02	86	1.19 (0.90-1.58)	0.23
	18.5-24.9	3787	1.00	Referent	1601	1.00	Referent
	25.0-29.9	2716	1.10 (1.00-1.21)	0.05	572	0.99 (0.87-1.13)	0.91
	≥30	606	1.30 (1.11-1.52)	<0.01	13	0.96 (0.46-2.02)	0.91
Smoked 100 Cigarettes in Life	No	4836	1.00	Referent	1694	1.00	Referent
	Yes	2439	1.35 (1.23-1.47)	<0.01	588	1.48 (1.31-1.68)	<0.01
Age Started Smoking	Never	3666	1.00	Referent	1403	1.00	Referent
	<13 years	319	1.81 (1.50-2.19)	<0.01	99	1.77 (1.37-2.27)	<0.01
	13-16	2023	1.23 (1.11-1.37)	<0.01	471	1.29 (1.12-1.48)	<0.01
	≥17	1274	1.10 (0.97-1.24)	0.16	312	1.35 (1.15-1.59)	<0.01
Days Smoked 30 Days Before BT	None	5292	1.00	Referent	1782	1.00	Referent
	1-9 days	505	1.27 (1.08-1.51)	<0.01	137	1.37 (1.10-1.72)	<0.01
	10-19	372	1.22 (1.00-1.49)	0.05	73	1.36 (1.00-1.84)	0.05
	≥20	1108	1.50 (1.34-1.69)	<0.01	291	1.51 (1.29-1.77)	<0.01
Cigarettes Smoked in 30 Days Before BT	None	5318	1.00	Referent	1792	1.00	Referent
	1-9 cig/day	1213	1.33 (1.19-1.50)	<0.01	309	1.29 (1.10-1.52)	<0.01
	10-19	510	1.40 (1.19-1.65)	<0.01	136	1.67 (1.35-2.08)	<0.01
	≥20	239	1.68 (1.36-2.09)	<0.01	47	2.07 (1.50-2.87)	<0.01
Days of Smokeless Tobacco Use	None	6273	1.00	Referent	2234	1.00	Referent
	1-9 days	253	0.96 (0.75-1.23)	0.73	21	1.38 (0.82-2.35)	0.23
	10-19	173	1.06 (0.80-1.41)	0.67	11	1.47 (0.73-2.94)	0.28
	≥20	580	0.90 (0.76-1.06)	0.21	18	1.22 (0.65-2.27)	0.54
Amount of Smokeless Tobacco Use	None	6267	1.00	Referent	2239	1.00	Referent
	≤3/4 cans,plugs	530	0.94 (0.79-1.12)	0.49	26	1.56 (0.95-2.56)	0.08
	1 to 1-3/4	372	0.91 (0.74-1.12)	0.37	14	1.26 (0.68-2.35)	0.47
	≥2	107	1.15 (0.83-1.61)	0.40	6	1.23 (0.46-3.28)	0.68
Activity Before BT Compared to Peers	Much Less Active	403	2.02 (1.81-2.68)	<0.01	287	2.14 (1.67-2.76)	<0.01
	Less Active	1312	1.78 (1.52-2.07)	<0.01	555	1.55 (1.23-1.97)	<0.01
	Average	1834	1.42 (1.22-1.65)	<0.01	627	1.42 (1.13-1.79)	<0.01
	More Active	2503	1.05 (0.91-1.22)	0.51	593	1.25 (0.99-1.59)	0.06
	Much More Active	1222	1.00	Referent	220	1.00	Referent
Exercise or Sports Frequency 2 Months Before BT	≤1 time/wk	916	1.87 (1.63-2.14)	<0.01	442	1.49 (1.25-1.77)	<0.01
	2-4	3911	1.24 (1.12-1.38)	<0.01	1267	1.34 (1.16-1.54)	<0.01
	≤5	2448	1.00	Referent	574	1.00	Referent
Running/ Jogging Frequency 2 Months before BT	≤1 time/wk	2008	1.44 (1.25-1.66)	<0.01	750	1.47 (1.22-1.79)	<0.01
	2-4	4141	0.96 (0.84-1.10)	0.58	1224	1.19 (0.99-1.43)	0.07
	≤5	1116	1.00	Referent	302	1.00	Referent
Running/ Jogging Time 2 Months before BT	≤1 month	2129	1.52 (1.32-1.74)	<0.01	740	1.83 (1.51-2.21)	<0.01
	2-6	3886	1.12 (0.99-1.28)	0.08	1196	1.52 (1.27-1.83)	<0.01
	≤7	1255	1.00	Referent	346	1.00	Referent

Variable	Strata	Men			Women		
		N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Weight Training Frequency 2 Months before BT	≤1 time/wk	2974	1.31 (1.15-1.49)	<0.01	1232	1.04 (0.82-1.30)	0.77
	2-4	3090	1.03 (0.90-1.18)	0.62	894	0.87 (0.68-1.10)	0.23
	≤5	1204	1.00	Referent	153	1.00	Referent
Weight Training Time 2 Months before BT	≤1 month	3074	1.36 (1.22-1.53)	<0.01	1316	1.43 (1.18-1.75)	<0.01
	2-6	2318	1.14 (1.01-1.29)	0.03	704	1.27 (1.03-1.56)	0.03
	≤7	1885	1.00	Referent	259	1.00	Referent
Prior Lower Limb Injury	No	5607	1.00	Referent	1782	1.00	Referent
	Yes	1670	1.32 (1.19-1.45)	<0.01	503	1.24 (1.10-1.42)	<0.01
Prior Injury Prevent Activities ≥1 Week	No Prior Injury	5607	1.00	Referent	1782	1.00	Referent
	No	616	1.13 (0.97-1.33)	0.12	169	1.23 (1.00-1.52)	0.05
	Yes	1046	1.42 (1.27-1.60)	<0.01	331	1.26 (1.08-1.48)	<0.01
Totally Recovered from Prior Injury	No Prior Injury	5602	1.00	Referent	1783	1.00	Referent
	No	93	2.56 (1.91-3.42)	<0.01	50	2.44 (1.77-3.36)	<0.01
	Yes	1566	1.26 (1.13-1.39)	<0.01	447	1.16 (1.01-1.33)	0.04
Age at Menarche	No Menses Yet				15	1.59 (0.85-2.96)	0.15
	6-10 years				1807	1.00	Referent
	11-14				201	1.07 (0.88-1.30)	0.51
	15-17				262	1.08 (0.91-1.29)	0.38
Menstrual Cycles in Last Year	No Cycles				69	1.47 (1.10-1.98)	0.01
	1-9 cycles				402	1.24 (1.08-1.44)	<0.01
	10-12				1666	1.00	Referent
	≥13				104	1.25 (0.97-1.63)	0.09
Gone ≥6 Months without Menstrual Cycle	No				1940	1.00	Referent
	Yes				156	1.42 (1.15-1.73)	<0.01
	No Menses Yet				15	1.60 (0.86-2.98)	0.14
Taken Birth Control Pills in Last 12 Months	No				1322	1.00	Referent
	Yes				938	1.16 (1.04-1.30)	0.01
Time Since Last Pregnancy	Never Pregnant				1891	1.00	Referent
	1-12 Months Ago				76	1.12 (0.82-1.53)	0.49
	≥13				318	1.28 (1.10-1.50)	<0.01

Abbreviations: CI=confidence interval; BT=basic training

Table 11 shows the univariate Cox regression for the AT group for all types of training combined. Among both men and women, injury risk was lower in the intervention period compared to the baseline period. Among both men and women, injury risk was higher among those who were in MP and ENG training, were older, had smoked at least 100 cigarettes in their life, had started smoking earlier in life, had smoked in the 30 days before training, had rated themselves as less physically active compared to their peers, had a lower frequency of exercise or sport in the 2 months before training, had a lower frequency or shorter history of running, had a shorter history of weight training, or had not totally recovered from a prior lower limb injury. In addition, men were at higher injury risk if they had very low or very high BMI, a lower frequency of weight training and had a prior lower limb injury, especially if that injury restricted activity for ≥ one week. Women were at higher risk if they had no menstrual cycles in the last year, had gone ≥ 6 months without a menstrual cycle, had used birth control pills in the last year, or had been pregnant.

Table 11. Univariate Cox Regression for AT Group for All Types of Training Combined

Variable	Strata	Men			Women		
		N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Phase	Baseline	3526	1.00	Referent	748	1.00	Referent
	Intervention	2412	0.77 (0.70-0.84)		598	0.83 (0.72-0.95)	<0.01
Training Type	BCT	2044	1.00	Referent	684	1.00	Referent
	MP	1962	1.59 (1.53-1.66)	<0.01	619	1.61 (1.53-1.71)	<0.01
	ENG	1932	1.83 (1.75-1.92)	<0.01	43	1.79 (1.53-2.19)	<0.01
Age	<20.0 years	2971	1.00	Referent	709	1.00	Referent
	20.0-24.9	2209	1.20 (1.09-1.36)	<0.01	473	1.23 (1.07-1.42)	<0.01
	25.0-29.9	483	1.43 (1.22-1.66)	<0.01	99	1.08 (0.82-1.42)	0.61
	≥30.0	275	2.04 (1.71-2.44)	<0.01	65	1.55 (1.14-2.12)	<0.01
Body Mass Index	<18.5 kg/m^2	101	1.36 (1.00-1.85)	0.05	38	0.97 (0.64-1.47)	0.87
	18.5-24.9	3211	1.00	Referent	942	1.00	Referent
	25.0-29.9	2136	1.07 (0.97-1.17)	0.16	354	0.96 (0.82-1.12)	0.58
	≥30	475	1.39 (1.20-1.62)	<0.01	6	0.86 (0.28-2.67)	0.79
Smoked 100 Cigarettes in Life	No	4054	1.00	Referent	1006	1.00	Referent
	Yes	1879	1.41 (1.29-1.54)	<0.01	339	1.34 (1.15-1.56)	<0.01
Age Started Smoking	Never	3042	1.00	Referent	818	1.00	Referent
	<13 years	262	1.49 (1.23-1.81)	<0.01	50	1.57 (1.11-2.21)	0.01
	13-16	1606	1.27 (1.15-1.40)	<0.01	305	1.15 (0.98-1.36)	0.10
	≥17	1028	1.08 (0.96-1.22)	0.20	173	1.13 (0.92-1.39)	0.26
Days Smoked 30 Days Before BT	None	4355	1.00	Referent	1068	1.00	Referent
	1-9 days	465	1.20 (1.03-1.41)	0.02	60	1.27 (0.92-1.75)	0.14
	10-19	245	0.97 (0.78-1.22)	0.81	36	1.50 (1.02-2.22)	0.04
	≥20	869	1.53 (1.37-1.71)	<0.01	182	1.39 (1.15-1.68)	<0.01
Cigarettes Smoked in 30 Days Before BT	None	4376	1.00	Referent	1070	1.00	Referent
	1-9 cig/day	949	1.19 (1.06-1.34)	<0.01	178	1.28 (1.06-1.56)	0.01
	10-19	420	1.55 (1.34-1.80)	<0.01	72	1.49 (1.12-1.99)	<0.01
	≥20	188	1.73 (1.41-2.14)	<0.01	26	2.16 (1.41-3.30)	<0.01
Days of Smokeless Tobacco Use	None	4996	1.00	Referent	1313	1.00	Referent
	1-9 days	214	1.14 (0.92-1.42)	0.24	15	0.67 (0.32-1.42)	0.30
	10-19	167	0.87 (0.66-1.13)	0.29	8	1.16 (0.52-2.59)	0.72
	≥20	561	0.87 (0.75-1.02)	0.09	10	0.62 (0.23-1.65)	0.34
Amount of Smokeless Tobacco Use	None	5013	1.00	Referent	1314	1.00	Referent
	≤3/4 cans,plugs	497	0.76 (0.65-0.91)	<0.01	23	0.70 (0.39-1.28)	0.25
	1 to 1-3/4	322	1.03 (0.86-1.24)	0.73	7	1.19 (0.49-2.86)	0.70
	≥2	99	1.42 (1.06-1.89)	0.02	1	-----	-----
Activity Before BT Compared to Peers	Much Less Active	268	1.99 (1.61-2.45)	<0.01	176	2.13 (1.58-2.86)	<0.01
	Less Active	1041	1.77 (1.53-2.05)	<0.01	329	2.00 (1.52-2.62)	<0.01
	Average	1505	1.35 (1.17-1.55)	<0.01	338	1.45 (1.10-1.91)	<0.01
	More Active	2077	1.17 (1.02-1.35)	0.02	365	1.18 (0.90-1.56)	0.24
	Much More Active	1034	1.00	Referent	138	1.00	Referent
Exercise or Sports Frequency 2 Months Before BT	≤1 time/wk	647	1.68 (1.46-1.93)	<0.01	265	1.76 (1.43-2.16)	<0.01
	2-4	3195	1.23 (1.12-1.36)	<0.01	736	1.39 (1.17-1.65)	<0.01
	≤5	2077	1.00	Referent	341	1.00	Referent
Running/ Jogging Frequency 2 Months before BT	≤1 time/wk	1554	1.43 (1.24-1.65)	<0.01	470	1.70 (1.35-2.14)	<0.01
	2-4	3517	1.09 (0.96-1.25)	0.20	687	1.33 (1.06-1.66)	0.01
	≤5	854	1.00	Referent	189	1.00	Referent
Running/ Jogging Time 2 Months before BT	≤1 month	1543	1.80 (1.57-2.07)	<0.01	433	2.09 (1.65-2.64)	<0.01
	2-6	3261	1.38 (1.22-1.57)	<0.01	686	1.88 (1.51-2.35)	<0.01
	≤7	1126	1.00	Referent	222	1.00	Referent

Variable	Strata	Men			Women		
		N	Hazard Ratio (95% CI)	p-value	N	Hazard Ratio (95% CI)	p-value
Weight Training Frequency 2 Months before BT	≤1 time/wk	2240	1.27 (1.12-1.44)	<0.01	741	1.24 (0.95-1.62)	0.11
	2-4	2689	1.00 (0.88-1.13)	0.96	495	0.94 (0.71-1.24)	0.67
	≤5	1001	1.00	Referent	106	1.00	Referent
Weight Training Time 2 Months before BT	≤1 month	2327	1.47 (1.32-1.64)	<0.01	786	1.80 (1.43-2.28)	<0.01
	2-6	1935	1.26 (1.12-1.41)	<0.01	381	1.52 (1.18-1.96)	<0.01
	≤7	1669	1.00	Referent	179	1.00	Referent
Prior Lower Limb Injury	No	4483	1.00	Referent	1035	1.00	Referent
	Yes	1449	1.23 (1.11-1.35)	<0.01	310	1.13 (0.96-1.33)	0.13
Prior Injury Prevent Activities ≥1 Week	No Prior Injury	4483	1.00	Referent	1035	1.00	Referent
	No	519	1.12 (0.96-1.30)	0.14	98	1.07 (0.82-1.39)	0.63
	Yes	927	1.28 (1.15-1.44)	<0.01	212	1.16 (0.97-1.40)	0.11
Totally Recovered from Prior Injury	No Prior Injury	4472	1.00	Referent	1035	1.00	Referent
	No	84	2.38 (1.79-3.17)	<0.01	23	2.06 (1.29-3.30)	<0.01
	Yes	1356	1.17 (1.06-1.29)	<0.01	286	1.09 (0.92-1.29)	0.32
Age at Menarche	No Menses Yet				6	0.40 (0.10-1.58)	0.19
	6-10 years				1028	1.00	Referent
	11-14				161	1.11 (0.90-1.36)	0.34
	15-17				151	0.95 (0.76-1.19)	0.66
Menstrual Cycles in Last Year	No Cycles				45	1.64 (1.16-2.30)	<0.01
	1-9 cycles				207	0.95 (0.78-1.16)	0.60
	10-12				984	1.00	Referent
	≥13				47	1.42 (1.01-2.01)	0.05
Gone ≥6 Months without Menstrual Cycle	No				1177	1.00	Referent
	Yes				91	1.39 (1.07-1.80)	0.01
	No Menses Yet				9	0.64 (0.24-1.71)	0.37
Taken Birth Control Pills in Last 12 Months	No				771	1.00	Referent
	Yes				564	1.27 (1.11-1.46)	<0.01
Time Since Last Pregnancy	Never Pregnant				1178	1.00	Referent
	1-12 Months Ago				19	1.63 (0.98-2.73)	0.06
	≥13				149	1.58 (1.29-1.93)	<0.01

Abbreviations: CI=confidence interval; BT=basic training

Table 12 shows the multivariate Cox regression results showing the HRs with all the significant covariates included in the analyses for each group and each type of training. For all types of training and for both groups, injury risk remained lower in the intervention period, compared to the baseline period. One exception was ENG women in the AT group where risk was elevated in the intervention period (recall that sample sizes were very small among the ENG women). For BCT, HRs comparing the intervention phase to the baseline phase were similar for the men in MAT and AT groups; HRs were lower for the women in the MAT group compared to the AT group (indicating a greater reduction in risk in the MAT group). For MP training, HRs were lower for the men and women in the AT group, compared to the MAT group. For ENG training HRs were lower for the men and women in the MAT group, compared to the AT group. When all types of training were combined, HRs were lower for the men in the AT group but lower for the women in the MAT group.

Table 12. Multivariate Cox Regression Results

Training Type	Men		Women	
	MAT HR-Intervention/ Baseline (95%CI)	AT HR-Intervention/ Baseline (95%CI)	MAT HR-Intervention/ Baseline (95%CI)	AT HR-Intervention/ Baseline (95%CI)
BCT	0.88 (0.78-0.99)	0.85 (0.74-0.99)	0.72 (0.63-0.82)	0.88 (0.73-1.06)
MP	0.82 (0.66-1.01)	0.64 (0.53-0.78)	0.83 (0.63-1.08)	0.62(0.49-0.79)
ENG	0.51(0.41-0.62)	0.65(0.55-0.75)	0.64 (0.30-1.35)	1.22 (0.55-2.68)
All	0.83 (0.76-0.91)	0.77 (0.70-0.84)	0.74 (0.67-0.83)	0.83 (0.72-0.95)

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group, HR=hazard ratio, CI=confidence interval

7.3 Total Injury Encounters from the DMSS

Table 13 shows a comparison of the total number of injury encounters in the MAT and AT groups in the baseline phase and a comparison of the baseline and intervention periods within MAT and AT groups. These are visits for injuries that the recruit made to the local clinic or hospital recorded in the DMSS. A recruit could have made more than one visit. For the "Ratio of Encounters per Recruit" (last column in Table 12), a number <1 indicates a greater number of encounters/recruit in the baseline period; a number >1 indicates a greater number of encounters/recruit in the intervention period.

For the BCT recruits, the average number of encounters per recruit were higher in the baseline period for the AT group among both men and women. Among the men, there was little change from the baseline to the intervention period for either the MAT or AT group (about a 5% decline in the intervention period). Among the women, the number of encounters per recruit declined from the baseline to the intervention period for the MAT group (17%) but it increased for the AT group (19%).

For the MP recruits, the average number of encounters per recruit in the baseline period was similar for the MAT and AT groups for both the men and women. Among the men, the number of encounters per recruit declined from the baseline to the intervention period for both the MAT and AT groups, although the decline in the AT group was greater than that of the MAT (27% versus 36%). Among the women, there was little change from the baseline to the intervention period for the MAT group (3%), but the AT group showed a 27% decline from the baseline to the intervention period.

For the ENG recruits, the average number of encounters per recruit tended to be higher for the MAT group in the baseline period for both the men and women. Among the men, the number of encounters per recruit declined from the baseline to the intervention period for both the MAT and AT groups, although the decline with the MAT was greater than that of the ATs (46% versus 25%). Among the women, there was a 43% decline in the number of encounters per recruit from the baseline to

the intervention period in the MAT group but a 33% increase in the number of encounters in the AT group. However, the number of female engineers was small and they had a very high number of encounters per recruit.

When all types of training were combined, the average number of encounters per recruit were higher for the AT group in the baseline period for both the men and women. Among the men, the number of encounters per recruit declined from the baseline to the intervention period for both the MAT and AT group, and the decline was similar for both groups (19% for the MAT group and 17% for the AT group). Among the women, there was a 21% decline in the number of encounters per recruit from the baseline to the intervention period in the MAT group but the AT group changed little from the baseline to the intervention period (8%).

Table 13. Total Clinic/Hospital Encounters by Group, Phase, & Type of Training

Training Type	Gender	Group	Phase	Recruits (n)	Encounters (n)	Encounters/ Recruit (mean±SD)	p-value[a] (Comparison MAT to AT in Baseline Phase)	p-value[a] (Comparison of Baseline and Intervention Phases within Group)	Ratio of Encounters/ Recruit (Intervention/ Baseline)
BCT	Men	MAT	Baseline	2748	1576	0.57±1.43	<0.01	0.47	0.94
			Intervention	2423	1320	0.54±1.43			
		AT	Baseline	1059	1157	1.09±2.11		0.59	0.95
			Intervention	986	1027	1.04±2.11			
	Women	MAT	Baseline	818	1533	1.87±2.63	0.02	0.01	0.83
			Intervention	1043	1625	1.56±2.73			
		AT	Baseline	338	770	2.28±2.73		0.06	1.19
			Intervention	347	940	2.71±3.28			
MP	Men	MAT	Baseline	764	1001	1.31±2.03	0.92	0.03	0.73
			Intervention	417	400	0.96±3.62			
		AT	Baseline	1353	1307	0.97±2.17		<0.01	0.64
			Intervention	609	385	0.63±1.68			
	Women	MAT	Baseline	236	859	3.64±5.07	0.53	0.84	0.97
			Intervention	145	512	3.53±4.83			
		AT	Baseline	386	1309	3.39±4.68		0.02	0.73
			Intervention	233	574	2.46±4.98			
ENG	Men	MAT	Baseline	349	703	2.01±3.17	<0.01	<0.01	0.54
			Intervention	587	640	1.09±2.38			
		AT	Baseline	1114	1361	1.22±2.27		<0.01	0.75
			Intervention	818	755	0.92±2.02			
	Women	MAT	Baseline	14	97	6.93±5.78	0.08	0.08	0.57
			Intervention	30	119	3.96±4.81			
		AT	Baseline	24	77	3.21±6.36		0.61	1.33
			Intervention	19	81	4.26±7.09			

Training Type	Gender	Group	Phase	Recruits (n)	Encounters (n)	Encounters/ Recruit (mean±SD)	p-value[a] (Comparison MAT to AT in Baseline Phase)	p-value[a] (Comparison of Baseline and Intervention Phases within Group)	Ratio of Encounters/ Recruit (Intervention/ Baseline)
All	Men	MAT	Baseline	3861	3280	0.85±1.83	<0.01	<0.01	0.81
			Intervention	3427	2360	0.69±2.02			
		AT	Baseline	3526	3825	1.08±2.19		<0.01	0.83
			Intervention	2413	2167	0.90±1.99			
	Women	MAT	Baseline	1068	2489	2.33±3.49	<0.01	<0.01	0.79
			Intervention	1218	2256	1.85±3.20			
		AT	Baseline	748	2156	2.88±4.03		0.33	0.92
			Intervention	599	1595	2.66±4.18			

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group, MAT=musculoskeletal action team group
[a]Independent sample t-test

7.4 Injury Encounters from Comprehensive Injury Tracker

Table 14 shows the injury encounters in the intervention period from the Comprehensive Injury Tracker, the database maintained by the MAT and ATs. For the "Ratio of Recruit Encounters", a number <1 indicates a greater number of encounters/recruits for the AT group; a number >1 indicates a greater number of encounters/recruit for the MAT group. For men and women in BCT and ENG training, there were more encounters/recruit among those in the AT group. For men and women in MP training, there were more encounters/recruit in the MAT group. When all groups were combined, there were substantially more encounters/recruit among recruits in the AT group.

Table 14. Injury Encounters in the Intervention Phase from the Comprehensive Injury Tracker

Type of Training	Group	Men				Women			
		Total Recruits (n)	Total Encounters (n)	Encounters /Recruit	Ratio of Recruit Encounters (MAT/AT)	Total Recruits (n)	Total Encounters (n)	Encounters /Recruit	Ratio of Recruit Encounters (MAT/AT)
BCT	MAT	2423	337	0.14	0.59	1043	616	0.59	0.80
	AT	986	233	0.24		347	255	0.74	
MP	MAT	417	247	0.59	1.12	145	359	2.48	1.60
	AT	609	323	0.53		233	360	1.55	
ENG	MAT	587	125	0.21	0.17	30	65	2.17	0.55
	AT	818	1039	1.27		19	74	3.90	
All	MAT	3481	709	0.20	0.31	1218	1040	0.85	0.74
	AT	2413	1595	0.66		599	689	1.15	

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group

Appendix C contains other summary data from the Comprehensive Injury Tracker including activities associated with the injuries, anatomical locations, and diagnoses.

7.5 Injury Encounters, DMSS and Comprehensive Injury Tracker Combined

Combining encounters from the DMSS and Comprehensive Injury Tracker was undertaken to determine if the total number of patient encounters changed in the intervention period. It was not possible to perform statistics on these data because the Comprehensive Injury Tracker was de-identified and encounters could not be accurately identified by individual recruit to link to data from the DMSS.

Table 15 shows the total number of clinic/hospital medical encounters combined with MAT/AT encounters by group, phase, and type of training. The final column in Table 15 is the "Ratio-Encounters per Recruit. If this ratio >1, this indicates a higher number of encounters/recruit in the intervention period; if the ratio is <1, this indicates a lower number of encounters/recruit in the baseline period. The total number of encounters per recruit increased 15% to 65% in the intervention phase for men and women in the BCT and MP training. Men in the MAT group in ENG training, showed a 35% decrease in the number of encounters/recruit while women had a 12% decrease. Women in the AT group in ENG training showed a large increase in the number of encounters/recruit in the intervention phase in consonance with the BCT and MP men and women. When all types of training were combined, the total number of encounters/recruit increased substantially.

Table 15. Total Clinic/Hospital Medical Encounters and MAT/AT Encounters by Group, Phase, & Type of Training

Training Type	Gender	Group	Phase	Recruits (n)	Encounters (n)	Encounters/ Recruit	Ratio-Encounters per Recruit (Intervention/Baseline)
BCT	Men	MAT	Baseline	2748	1576	0.57	1.19
			Intervention	2423	1657	0.69	
		AT	Baseline	1059	1157	1.09	1.17
			Intervention	986	1260	1.28	
	Women	MAT	Baseline	818	1533	1.87	1.15
			Intervention	1043	2241	2.15	
		AT	Baseline	338	770	2.28	1.51
			Intervention	347	1195	3.44	
MP	Men	MAT	Baseline	764	1001	1.31	1.45
			Intervention	417	794	1.90	
		AT	Baseline	1353	1307	0.97	1.20
			Intervention	609	708	1.16	
	Women	MAT	Baseline	236	859	3.64	1.65
			Intervention	145	871	6.01	
		AT	Baseline	386	1309	3.39	1.18
			Intervention	233	934	4.01	

Training Type	Gender	Group	Phase	Recruits (n)	Encounters (n)	Encounters/ Recruit	Ratio-Encounters per Recruit (Intervention/Baseline)
ENG	Men	MAT	Baseline	349	703	2.01	0.65
			Intervention	587	765	1.30	
		AT	Baseline	1114	1361	1.22	1.80
			Intervention	818	1794	2.19	
	Women	MAT	Baseline	14	97	6.93	0.88
			Intervention	30	184	6.13	
		AT	Baseline	24	77	3.21	2.54
			Intervention	19	155	8.16	
All	Men	MAT	Baseline	3861	3280	0.85	1.11
			Intervention	3427	3216	0.94	
		AT	Baseline	3526	3825	1.08	1.44
			Intervention	2413	3762	1.56	
	Women	MAT	Baseline	1068	2489	2.33	1.16
			Intervention	1218	3296	2.71	
		AT	Baseline	748	2156	2.88	1.32
			Intervention	599	2284	3.81	

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group

Table 16 shows injury encounters in the intervention period for both the clinic/hospital and the MAT/ATs. This table was constructed to show the proportion of encounters handled by the MAT/ATs. Among the men, the MAT handled16% to 31% of the combined encounters, while the ATs handled 19% to 58% of the total encounters. Overall, the ATs had twice the number of male encounters compared to the MAT. Among the women, the MAT handled 28% to 41% of the combined encounters, while the AT handled 21% to 48% of the total encounters. The MAT and ATs accounted for about the same proportion of total female encounters.

Table 16. Injury Encounters in the Intervention Period and Proportion of Intervention Encounters Seen by MAT/ATs

Type of Training	Group	Male Encounters				Female Encounters			
		Clinic/ Hospital (n)	MAT or AT (n)	Total (n)	MAT and AT (% of all encounters)	Clinic/ Hospital (n)	MAT or AT (n)	Total (n)	MAT and AT (% of all encounters)
BCT	MAT	1320	337	1657	20.3	1625	616	2241	27.5
	AT	1027	233	1260	18.5	940	255	1195	21.3
MP	MAT	547	247	794	31.1	512	359	871	41.2
	AT	385	323	708	45.6	574	360	934	38.5
ENG	MAT	640	125	765	16.3	119	65	184	35.3
	AT	755	1039	1794	57.9	81	74	155	47.7
All	MAT	2507	709	3216	22.0	2256	1040	3296	31.6
	AT	2167	1595	3762	42.4	1595	689	2284	30.2

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group

7.6 Attrition

Table 17 shows a comparison of discharge incidence between the MAT and AT groups in the baseline period and a comparison of the MAT and AT groups within phases. All discharges combined are shown and these are also separated into medical discharges and non-medical discharges.

Table 17 shows that in BCT, there was little difference between the MAT and AT groups in all discharges or non-medical discharges in the baseline period. However, there was a lower incidence of medical discharges among MAT group men compared to the AT group men in the baseline phase. Medical discharges substantially decreased in the intervention period among the MAT group men (38% decrease) while there was little change among the AT group men in the intervention phase (8% increase). There was little change in all discharges or non-medical discharges among either the MAT or AT men, although for the MAT men all discharges declined somewhat due primarily to the reduction in medical discharges.

Among women in BCT, there was little difference between the MAT and AT groups in the baseline phase for all discharges or medical discharges. However, the MAT group tended to have a higher non-medical discharge incidence than the AT group in the baseline period. While both groups showed a decline in medical discharges from the baseline to the intervention period, the declines were larger for the MAT group (50% versus 32%). Similarly, both groups showed a decline in all discharges from the baseline to the intervention period, the decline was larger for the MAT group (33%) than for the AT group (25%).

Among the male MP recruits, the incidences of all discharges and non-medical discharges were similar between groups in the baseline period while medical discharges were lower in the MAT group. Medical discharges were higher in the intervention period for the MAT group but changed little for the AT group. Non-medical discharges were slightly reduced in the intervention period for both groups. Primarily because of the increase in medical discharges, overall discharges in the intervention period were slightly higher in the MAT group (10%); overall discharge incidence was somewhat reduced in the AT group (17%).

Among the female MP recruits, the AT group tended to have a higher non-medical discharge incidence than the MAT group in the baseline period. The incidences of all discharges and medical discharges were similar among groups in the baseline period. Medical discharges slightly declined in the intervention phase in the MAT group (30%) but rose in the AT group (25%); these differences were of low statistical significance, presumably because of the smaller sample size. Non-medical discharge incidence increased in both groups in the intervention phase and this resulted in a rise in the overall discharge incidence in the intervention phase.

Among the male ENG recruits, the MAT group had a higher incidence of all discharges and medical discharges than the AT group in the baseline period with little difference between groups for non-medical discharges. Both the MAT and AT groups demonstrated declines in all discharges and medical discharges in the intervention phase. The declines were greater for the MAT group than for the AT group for both all discharges (66% versus 34%) and for medical discharges (92% versus 58%). Non-medical discharges also declined in both groups during the intervention phase, and this contributed to the overall decline in discharges.

Among the female ENGs, none of the differences were statistically significant, presumably due to the low statistical power. Ten of the ENG women were discharged (11%). Nonetheless, there were no medical discharges in the baseline or intervention periods for the MAT women but an increase in the intervention period for the AT women.

When all types of training were combined, there were only relatively small differences between the MAT and AT groups in the baseline period. Among the men, the MAT group showed a greater decline than the AT group in the intervention period for both medical discharges (38% vs. 14%) and all discharges (23% vs. 17%). Similarly among the women, the MAT group showed a greater decline than the AT group in the intervention period for both medical discharges (49% vs. 11%) and all discharges (26% vs. 7%). There were also small declines in non-medical discharges in the intervention period for both groups. The change in the number of recruits who were *not* medically discharged in the intervention period amounted to 6, 30, 3, and 8 recruits per 1,000 for MAT men, MAT women, AT men and AT women, respectively.

Table 17. Discharge Incidence: Comparison of Group Difference in the Baseline Phase and Comparison of Baseline and Intervention Phases within Groups.

Training Type	Gender	Discharge Type	Group	Discharged (%)		Risk Ratio-MAT/AT In Baseline Phase (95%CI)	Chi Square p-value	Risk Ratio-Baseline/ Intervention (95%CI)	Chi Square p-value
				Baseline	Intervention				
BCT	Men	All	MAT	4.4	3.6	0.83 (0.60-1.13)	0.24	1.19 (0.91-1.57)	0.20
			AT	5.2	4.9			1.01 (0.69-1.47)	0.96
		Medical	MAT	1.5	0.9	0.59 (0.36-0.96)	0.03	1.63 (0.98-2.73)	0.06
			AT	2.6	2.6			0.95(0.56-1.63)	0.86
		Non-Medical	MAT	2.8	2.7	1.04 (0.68-1.61)	0.85	1.04 (0.75-1.45)	0.79
			AT	2.7	2.4			1.07 (0.62-1.84)	0.81
	Women	All	MAT	13.6	9.1	1.19 (0.83-1.70)	0.34	1.48 (1.14-1.94)	<0.01
			AT	11.4	8.5			1.35 (0.84-2.17)	0.22
		Medical	MAT	5.5	2.8	0.87 (0.52-1.46)	0.60	2.01(1.25-3.23)	<0.01
			AT	6.5	4.4			1.50 (0.77-2.91)	0.23
		Non-Medical	MAT	8.0	6.4	1.64 (0.95-2.83)	0.07	1.31 (0.93-1.83)	0.12
			AT	4.9	4.1			1.23 (0.59-2.53)	0.58

Training Type	Gender	Discharge Type	Group	Discharged (%)		Risk Ratio-MAT/AT In Baseline Phase (95%CI)	Chi Square p-value	Risk Ratio-Baseline/ Intervention (95%CI)	Chi Square p-value
				Baseline	Intervention				
MP	Men	All	MAT	4.2	4.6	0.88 (0.58-1.34)	0.56	0.92 (0.53-1.61)	0.78
			AT	4.8	3.9			1.24 (0.77-1.98)	0.36
		Medical	MAT	0.8	1.9	0.44 (0.18-1.08)	0.07	0.42 (0.15-1.19)	0.09
			AT	1.8	1.7			1.08 (0.52-2.24)	0.84
		Non-Medical	MAT	3.4	2.7	1.14 (0.70-1.85)	0.60	1.28 (0.64-2.57)	0.48
			AT	3.0	2.2			1.37 (0.74-2.55)	0.31
	Women	All	MAT	13.0	15.1	0.90 (0.59-1.36)	0.61	0.87 (0.51-1.45)	0.58
			AT	14.6	16.4			0.89 (0.60-1.30)	0.54
		Medical	MAT	8.6	5.8	1.12 (0.64-1.96)	0.68	1.41 (0.64-3.13)	0.39
			AT	7.4	8.2			0.89 (0.50-1.57)	0.69
		Non-Medical	MAT	4.5	9.3	0.64 (0.32-1.29)	0.21	0.50 (0.22-1.10)	0.08
			AT	7.1	8.2			0.86 (0.49-1.52)	0.61
ENG	Men	All	MAT	9.9	3.4	1.63 (1.09-2.44)	0.02	2.88 (1.67-4.95)	<0.01
			AT	5.9	3.8			1.51 (1.00-2.30)	0.05
		Medical	MAT	6.2	0.5	2.55 (1.44-4.50)	<0.01	12.09 (3.62-40.36)	<0.01
			AT	2.4	1.0			2.40 (1.09-5.27)	0.02
		Non-Medical	MAT	3.7	2.9	1.06 (0.56-2.00)	0.86	1.35 (0.65-2.78)	0.42
			AT	3.5	2.9			1.23 (0.74-2.04)	0.43
	Women	All	MAT	0.0	10.3	-----	-----	-----	0.32
			AT	8.7	26.7			0.29 (0.06-1.39)	0.10
		Medical	MAT	0.0	0.0	-----	-----	-----	-----
			AT	8.7	20.0			0.36 (0.07-1.91)	0.21
		Non-Medical	MAT	0.0	10.3	-----	-----	-----	0.35
			AT	0.0	6.7			-----	0.20
All Training Types	Men	All	MAT	4.8	3.7	0.91 (0.74-1.11)	0.40	1.29 (1.03-1.61)	0.03
			AT	5.3	4.4			1.19 (0.94-1.51)	0.15
		Medical	MAT	1.6	1.0	0.80 (0.58-1.11)	0.18	1.81 (1.20-2.74)	<0.01
			AT	2.2	1.9			1.19 (0.83-1.72)	0.35
		Non-Medical	MAT	3.0	2.7	0.97 (0.75-1.27)	0.85	1.10 (0.84-1.44)	0.48
			AT	3.1	2.5			1.20 (0.87-1.64)	0.26
	Women	All	MAT	13.3	9.9	1.03 (0.80-1.26)	0.84	1.33 (1.05-1.68)	0.02
			AT	13.0	12.1			1.05 (0.78-1.41)	0.77
		Medical	MAT	6.1	3.1	0.88 (0.61-1.34)	0.47	2.00 (1.33-3.00)	<0.01
			AT	7.1	6.3			1.06 (0.69-1.62)	0.79
		Non-Medical	MAT	7.2	6.8	1.20 (0.83-1.74)	0.32	1.06 (0.78-1.45)	0.71
			AT	5.9	5.8			1.04 (0.66-1.62)	0.87

Abbreviations: CI=confidence interval; MAT-musculoskeletal action team group; AT=athletic trainer group; BCT=Basic Combat Training; MP=military police training; ENG=engineer training

In considering these cost savings, there are additional costs that are not considered here. These include the salaries of the ATs and MAT members, medical supply and equipment costs, and infrastructure costs (buildings, utilities, maintenance, etc.). A full cost analysis would include these and likely other factors.

7.7 Physical Fitness

In almost all companies, APFTs were not administered within the first week of training. Table 18 shows the time from the start of the training cycle to the first

APFT and indicates that APFTs were administered an average of over two weeks after the start of training. Since several physical training sessions were likely to have occurred, and since recruits were likely to have considerably increased their physical fitness in this time, the first APFT could not serve as a baseline level of fitness. Thus, only the final APFT was considered in the following analyses.

Table 18. Time from Cycle Start to First APFT

Phase	Training Type	MAT			AT		
		Mean±SD Time (days)	Minimum Time (days)	Maximum Time (days)	Mean±SD Time (days)	Minimum Time (days)	Maximum Time (days)
Baseline	BCT	17±6	10	33	13±1	12	15
	MP	17±2	15	20	14±14	1	39
	ENG	12±4	12	24	10±3	7	17
Intervention	BCT	15±5	7	34	13±3	11	19
	MP	17±3	14	22	16±4	10	24
	ENG	15±2	12	17	20±9	8	39

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training

Table 19 shows the comparison of the final APFT scores by group, phase and training type. Data combining all types of training is not shown because the length of training differed considerably for the different types of training (10 to 19 weeks) and groups with longer training time would have a longer period to acquire higher fitness levels. As noted in the Data Analysis section, data were analyzed using a two-way ANOVA. P-values for the two main effects (groups and phases) and interaction (groups X phases) are shown. There were few significant main effects in the ANOVA by group or phase. However, there were a number of significant group-by-phase interactions. Because of this, differences between the baseline and intervention periods were analyzed for the MAT and AT groups separately.

Table 19. APFT Data: Comparison of Final APFT Scores by Group and Phase

Training Type	Gender	Event	Phase	MAT		AT		ANOVA p-values		
				N	M±SD	N	M±SD	Group (AT vs. MAT)	Phase (Baseline vs. Intervention)	Group X Phase
BCT	Men	PU	Baseline	2616	53±14	954	53±13	0.28	0.82	0.33
			Intervention	2275	53±14	928	53±13			
		SU	Baseline	2616	61±12	955	63±11	0.87	0.93	<0.01
			Intervention	2274	63±12	928	62±12			
		2-Mile Run	Baseline	2605	15.0±1.5	944	14.8±1.4	0.22	0.15	0.03
			Intervention	2270	14.7±1.5	926	14.4±1.4			
		Total Points	Baseline	2591	224±38	943	230±36	0.22	0.49	0.09
			Intervention	2266	227±39	926	230±36			
	Women	PU	Baseline	681	31±13	276	31±12	0.92	0.68	0.30
			Intervention	896	32±14	294	31±12			
		SU	Baseline	680	57±12	276	61±12	0.73	0.87	<0.01
			Intervention	895	60±13	294	59±12			
		2-Mile Run	Baseline	680	18.0±2.0	270	17.6±1.7	0.34	0.30	0.10
			Intervention	891	17.6±2.0	293	17.5±1.7			
		Total Points	Baseline	673	219±39	270	230±38	0.43	0.85	0.01
			Intervention	886	225±42	293	226±39			
MP	Men	PU	Baseline	699	57±12	1265	62±13	0.37	0.75	<0.01
			Intervention	378	58±13	552	59±13			
		SU	Baseline	699	69±10	1265	72±11	0.39	0.87	<0.01
			Intervention	378	70±11	553	71±11			
		2-Mile Run	Baseline	621	14.1±1.1	1265	14.0±1.2	0.89	0.22	0.12
			Intervention	378	13.8±1.2	552	13.9±1.2			
		Total Points	Baseline	609	247±30	1264	256±30	0.46	0.74	<0.01
			Intervention	369	253±29	550	254±30			
	Women	PU	Baseline	184	36±11	315	43±12	0.69	0.99	<0.01
			Intervention	115	41±14	178	39±12			
		SU	Baseline	184	67±11	315	72±12	0.52	0.84	0.01
			Intervention	115	69±11	179	69±13			
		2-Mile Run	Baseline	165	16.8±1.5	314	16.7±1.6	0.61	0.36	<0.01
			Intervention	115	15.8±1.8	179	16.5±1.5			
		Total Points	Baseline	163	249±32	313	263±27	0.71	0.75	<0.01
			Intervention	111	262±30	176	257±31			
ENG	Men	PU	Baseline	296	56±12	1023	57±12	0.84	0.50	0.02
			Intervention	535	56±12	753	54±12			
		SU	Baseline	296	66±10	1023	65±10	0.35	0.59	0.01
			Intervention	535	68±10	753	65±10			
		2-Mile Run	Baseline	293	14.5±1.2	1023	14.2±1.1	0.10	0.19	0.36
			Intervention	534	14.3±1.2	740	14.0±1.2			
		Total Points	Baseline	272	240±27	1018	242±28	0.83	0.98	0.27
			Intervention	528	242±33	736	240±32			
	Women	PU	Baseline	9	45±16	21	45±18	0.53	0.07	0.86
			Intervention	27	39±15	10	38±13			
		SU	Baseline	9	67±13	21	69±12	0.29	0.85	0.64
			Intervention	27	65±11	10	65±10			
		2-Mile Run	Baseline	9	16.9±2.0	20	16.2±1.2	0.73	0.79	0.05
			Intervention	27	15.7±1.3	10	15.6±1.1			
		Total Points	Baseline	9	252±45	20	265±32	0.90	0.43	0.18
			Intervention	26	279±29	10	257±27			

Abbreviations: PU=push-ups; SU=sit-ups; ANOVA=analysis of variance; BCT=Basic Combat Training; MP=military

police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group; M=mean; SD=standard deviation

Table 20 shows differences between the baseline and intervention periods analyzed separately for the MAT and AT groups. These data indicate that the significant interactions in Table 19 were because MAT group push-up and sit-up values tended to remain the same or increase from the baseline to the intervention period. On the other hand, AT group push-up and sit-up values tended to remain the same or decrease from the baseline to the intervention phase. Two-mile run performance generally increased in both the MAT and AT groups. Total APFT points tended to remain the same or increase from the baseline to the intervention period for the MAT group, while total APFT points tended to remain the same or decrease for the AT group. The change in total APFT points from the baseline to the intervention period for the MAT group ranged from 1.3% to 10.7%; the change in total APFT points from the baseline to the intervention period for the AT group ranged from -2.3% to 3.0%.

Table 20. APFT Data: Comparison of Final APFT Scores by Phase, within Groups

Training Type	Gender	Event	Phase	MAT		ANOVA p-values MAT Base vs Int)	AT		ANOVA p-values (AT Base vs. Int)	ANOVA p-value (MAT vs. AT in Base)	ANOVA p-value (MAT vs. AT in Int)
				N	M±SD		N	M±SD			
BCT	Men	PU	Baseline	2616	53±14	0.51	954	53±13	0.45	0.41	
			Intervention	2275	53±14		928	53±13			0.13
		SU	Baseline	2616	61±12	<0.01	955	63±11	<0.01	<0.01	
			Intervention	2274	63±12		928	62±12			<0.01
		2-Mile Run	Baseline	2605	15.0±1.5	<0.01	944	14.8±1.4	<0.01	<0.01	
			Intervention	2270	14.7±1.5		926	14.4±1.4			<0.01
		Total Points	Baseline	2591	224±38	<0.01	943	230±36	0.97	<0.01	
			Intervention	2266	227±39		926	230±36			0.04
	Women	PU	Baseline	681	31±13	0.33	276	31±12	0.77	0.41	
			Intervention	896	32±14		294	31±12			0.52
		SU	Baseline	680	57±12	<0.01	276	61±12	0.08	<0.01	
			Intervention	895	60±13		294	59±12			0.14
		2-Mile Run	Baseline	680	18.0±2.0	<0.01	270	17.6±1.7	0.32	<0.01	
			Intervention	891	17.6±2.0		293	17.5±1.7			0.40
		Total Points	Baseline	673	219±39	<0.01	270	230±38	0.25	<0.01	
			Intervention	886	225±42		293	226±39			0.65
MP	Men	PU	Baseline	699	57±12	0.18	1265	62±13	<0.01	<0.01	
			Intervention	378	58±13		552	59±13			0.25
		SU	Baseline	699	69±10	0.03	1265	72±11	0.09	<0.01	
			Intervention	378	70±11		553	71±11			0.50
		2-Mile Run	Baseline	621	14.1±1.1	<0.01	1265	14.0±1.2	0.03	0.27	
			Intervention	378	13.8±1.2		552	13.9±1.2			0.26
		Total Points	Baseline	609	247±30	<0.01	1264	256±30	0.10	<0.01	
			Intervention	369	253±29		550	254±30			0.79
	Women	PU	Baseline	184	36±11	<0.01	315	43±12	<0.01	<0.01	
			Intervention	115	41±14		178	39±12			0.17
		SU	Baseline	184	67±11	0.19	315	72±12	0.01	<0.01	
			Intervention	115	69±11		179	69±13			0.94
		2-Mile Run	Baseline	165	16.8±1.5	<0.01	314	16.7±1.6	0.10	0.43	
			Intervention	115	15.8±1.8		179	16.5±1.5			<0.01
		Total Points	Baseline	163	249±32	<0.01	313	263±27	0.05	<0.01	
			Intervention	111	262±30		176	257±31			0.20
ENG	Men	PU	Baseline	296	56±12	0.99	1023	57±12	<0.01	0.24	
			Intervention	535	56±12		753	54±12			0.02
		SU	Baseline	296	66±10	0.01	1023	65±10	0.57	0.31	
			Intervention	535	68±10		753	65±10			<0.01
		2-Mile Run	Baseline	293	14.5±1.2	0.23	1023	14.2±1.1	<0.01	<0.01	
			Intervention	534	14.3±1.2		740	14.0±1.2			<0.01
		Total Points	Baseline	272	240±27	0.53	1018	242±28	0.28	0.31	
			Intervention	528	242±33		736	240±32			0.56
	Women	PU	Baseline	9	45±16	0.31	21	45±18	0.24	0.99	
			Intervention	27	39±15		10	38±13			0.79
		SU	Baseline	9	67±13	0.66	21	69±12	0.26	0.62	
			Intervention	27	65±11		10	65±10			0.90
		2-Mile Run	Baseline	9	16.9±2.0	0.12	20	16.2±1.2	0.19	0.36	
			Intervention	27	15.7±1.3		10	15.6±1.1			0.07
		Total Points	Baseline	9	252±45	0.10	20	265±32	0.80	0.25	
			Intervention	26	279±29		10	257±27			0.44

Abbreviations: PU=push-ups; SU=sit-ups; ANOVA=analysis of variance; Base=baseline; Int=intervention; M=mean; SD=standard deviation; BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group

Although the MAT group generally increased performance on push-ups and sit-ups, it should also be noted that the MAT group baseline performance was lower than that of the AT group at baseline. In 18 comparisons (3 APFT events, 2 genders, 3 types of training), the AT group had higher baseline performance in 14 cases and 11 of these were statistically significant ($p<0.05$). The MAT group had higher baseline performance in only 1 case and scores were identical in 3 cases. In the intervention period, the AT group had higher performance in 6 cases (2 statistically significant at $p<0.05$), the MAT group in 9 cases (4 statistically significant at $p<0.05$), and scores were identical in 3 cases. Thus, despite the lower baseline performance of the MAT group, the MAT had generally higher performance than the AT group in the intervention period.

As noted in the Data Analysis section, there were some differences in age, body weight and BMI between the baseline and intervention phases, so these variables were entered as covariates in an ANCOVA. These data are shown in Appendix D. For all types of training, adjustment for age, body weight, or BMI made very little difference in the p-values by group or phase. One exception was the age adjusted for total APFT points for BCT women. In this case, difference between the intervention and baseline phases became larger for the MAT group and smaller for the AT group.

8 DISCUSSION

The major purpose of this investigation was to compare the injuries, attrition, and physical fitness among IET units who received treatment and injury prevention advice from the MAT compared to IET units that received these services from ATs. There were several problems with the injury and fitness data. For the injury data, the baseline levels of injuries differed in the MAT and AT groups for most analyses and there were no statistical techniques available to control for different baseline levels when there were different individuals in different groups. Thus, the approach taken was to examine the magnitude of the changes from the baseline to the intervention phase within a group and then compare these changes between the MAT and AT groups. For the fitness data, APFTs were not administered within the first week of training but rather an average of more than two weeks after the start of training. Several physical training sessions were likely to have been conducted in this time and recruits were likely to have considerably increased their physical fitness in this time, as was found in previous basic training investigations.[35, 77] Thus, the first APFT could not serve as a baseline level of fitness and only the final APFT

was considered in the analysis. Despite these problems, several facts were apparent. For injuries, both the MAT and AT demonstrated a reduction in the number of injured recruits and a reduction in the number of visits to the clinic/hospital. However, whether the reductions were greater for the MAT or AT depended on the type of training or gender and neither group had more favorable outcomes compared to the other. For the attrition and fitness data, outcomes were somewhat less ambigious and seem to favor the MAT group. While both the MAT and the AT showed intervention period declines in all discharges and medical discharges, the declines were generally larger in the MAT group. Likewise, intervention period APFT performance for push-ups and sit-ups tended to remain the same or increase for the MAT group, while they remained the same or declined for the AT group. Run performance increased for both groups but total APFT scores (points) generally favored the MAT group, primarily because of changes in push-up and sit-up performance. These issues are discussed in more detail below.

8.1 Injuries

There were three major questions with regard to the injury data. The first was whether or not there was a reduction in the number of injured recruits seen in the clinic/hospital during the intervention period with the MAT and/or AT. The second question was whether or not the number of injury encounters per recruit seen in the clinic/hospital changed in the intervention period with the MAT or AT. The third question was whether or not the total number of encounters (clinic/hospital visits plus MAT/AT encounters) changed in the intervention period with the MAT and/or AT.

With regard to the first question (cumulative injury incidence), BCT men in both MAT and AT groups showed a similar reduction in the number of injured recruits in the intervention period; however, among the BCT women, the reduction was larger for the MAT group. Among the MPs, the AT group tended to have a larger decline in injury incidence from the baseline to the intervention period for both men and women. Among the male and female ENG recruits, the MAT group had a greater reduction in the intervention period. Thus, both the MAT and AT groups had reductions in the number of injured recruits seen in the clinic/hospital and which group had more favorable declines depended on the type of training.

It is useful to compare injury incidences and injury rates in the present project with those of past investigations to see if these data are representative. As noted in the introduction (Table 1) cumulative injury incidence in BCT has ranged from 14% to 42% of men and 41% to 67% of women. The cumulative injury incidence among BCT recruits (CII for MAT and AT combined) was 28% and 60% respectively, which fall within the previously reported ranges. However, BCT was extended from 8 weeks to 9 weeks in 1998 and is currently 10 weeks in length. Thus, it may be more

appropriate to compare injury rates to correct for time at risk. Injury incidence rates in BCT past studies have ranged from 6 to 33 injuries/100 soldiers per month for men, and 21 to 33 to injuries/100 soldiers per month for women (Table 1). In the present investigation the injury incidence rate was 11 and 24 injuries/100 recruits per month in the baseline period among male and female BCT recruits, respectively (MAT and AT groups data combined). Thus, BCT rates in the present investigation were generally on the lower end of the injury rate range from past studies. One previous unpublished investigation of MPs at Fort Leonard Wood in 2002 (Hauret, personal communication) reported injury rates of 6 and 16 injuries/100 recruits per month among men and women, respectively. This compares with the baseline rates in the present project of 7 and 14 injuries/100 recruits per month among men and women, respectively (MAT and AT groups data combined). The same unpublished 2002 Fort Leonard Wood investigation reported a male ENG injury rate of 11 injuries/100 recruits per month, and this compares to a rate of 13 injuries/100 recruits per month among ENG men in the baseline period of the present project (MAT and AT groups data combined). Thus, baseline injury rates for MP and ENG recruits in the present investigation were similar to those of the 2002 investigation.

In consonance with past studies,[5, 13, 15, 31, 45] other factors were found to affect BCT injury risk. These included older age, BMI, cigarette smoking, physical activity before training, prior injuries, and menstrual history. Nonetheless, even after accounting for these factors in multivariate analyses the results were similar to that found for cumulative injury incidence. That is, 1) the reduction in injury risk in the intervention period was similar for the MAT and AT groups among the BCT men, 2) the women in BCT and both the men and women in ENG training had a greater reduction in the intervention period in the MAT group, and 3) men and women in MP training had greater reductions in the intervention period in the AT group. Thus, both the MAT and AT groups had reductions in injury risk but which group had more favorable reductions depended on the type of training, even after controlling for other known injury risk factors.

A second question was whether the number of encounters at the clinic/hospital was reduced as a result of having the MAT and AT. It was generally found, with a few exceptions, that the number of clinic/hospital encounters per recruit declined in the intervention period for both the MAT and AT groups. For BCT men the decline in the number of encounters per recruit in the intervention period was small and similar in the MAT and AT groups. The BCT women in the MAT group showed a decline in the number of encounters in the intervention period but the AT group actually had an increase in the number of visits per recruit. For MP men and women, the decline in the number of encounters per recruit was greater in the AT group; however, for male ENGs the decline was greater for the MAT and in the small cohort of female ENG recruits, the AT group actually had an increase in the number of encounters per recruit. Thus, both the MAT and AT groups generally had reductions in the number

of encounters per recruit but in a few cases, the AT group had an increase in the number of encounters per recruit.

A third question was whether the total number of encounters per recruit (clinic/hospital plus MAT and AT encounters) changed in the intervention period compared to the baseline period and if there was a difference between the MAT and AT groups. There was generally an increase in the total number of encounters in the intervention period for both the MAT and AT groups, with some exceptions. For the BCT men, the increase from the baseline to the intervention period was similar in the MAT and AT groups but among the BCT women, the increase was larger in the AT group. For the male and female MP recruits, the increase in the intervention period was larger for the MAT. For the male and female ENG recruits, the MAT group had a decrease in the number of encounters per recruit while the AT group had an increase. Thus, both the MAT and the AT group generally had an increase in the total number of encounters and which group had a larger increase depended on the type of training. The increase was likely because the recruits had more readily available medical care. Recruit might have chosen to ignore an injury if the only medical access was the clinic/hospital because of the distance and/or the amount of time such a visit might have entailed. Medical access provided by the MAT and AT was much faster and in many cases closer to the unit.

Thus, outcomes from the injury data did not clearly favor either the MAT or AT group. This may not be surprising because both groups were providing readily available and early care/treatment to the recruits. It appears that both groups were effective in reducing the number of injured recruits and the number of encounters seen in the clinic/hospital. However, it should also be noted that the clinic/hospital still handled the majority of injury-related medical encounters. Overall, the MAT and ATs handled about 1/3 (32%) of all encounters in the intervention phase while the clinic/hospital saw the remainder.

The proximity of treatment rooms to the training battalions appeared to have had some effect on the reduction in the number of injury visits to the clinic/hospital. The AT involved with the BCT battalion had the smallest decline in the number of injured recruits and in the number of clinic/hospital visits; the declines among the ATs in the MP and ENG units were much larger (the small number of female ENGs excluded). For AT working with the BCT battalion, the treatment room was geographically located farther away from the unit. The Consolidated Troop Medical Clinic (CTMC) where the recruits could obtain more comprehensive medical care was actually closer to the unit. Thus, BCT recruits in the AT group actually had a shorter travel distance to the CTMC. The ATs with the MP and ENG units had their treatment rooms located within the ENG and MP battalions so they were more readily available to their recruits. Being located within the unit appears to have had advantages, not

only because of travel distance, but also because of more convenient access to commanders and cadre to provide injury prevention advice.

However, the MAT was also located some distance from the training units and still showed reductions in the proportion of injured recruits and number of clinic and hospital visits that were comparable to that of the ATs. It is possible that the additional expertise and support provided by the physical therapist, physical therapy assistant, and strength and conditioning specialists had advantages for injury reduction over and above that of geographic location. Another consideration was the fact that the MAT treatment room was located about 50 yards from the CTMC. If a recruit went to the CTMC they had to wait longer for care. A visit to the CTMC could take a half day because of the low number of medical care providers and the large number of recruits seeking care. In the MAT treatment room, care could be relatively rapid. MAT members indicated that the average wait time was 30-45 minutes with maximal wait times of 1.5 hours. Besides additional expertise and training time that the MAT saved the recruit, other currently unidentified factors may also be involved in reducing the number of injured recruits and clinic/hospital visits.

Compared to the MAT, number of encounters/recruit (Comprehensive Injury Tracker data) for the ATs were over twice as great (0.37 vs. 0.76 encounters/recruit, men and women combined). By far, the largest number of encounters/recruit was in the ENG battalion seen by an AT. This AT had very good communication with the companies in the ENG unit and her treatment room was located directly in the training battalion. On the other hand, the MP unit seen by the AT was the only one that had a lower number of encounters per recruit compared to the comparable unit (MP) seen by the MAT (0.74 vs. 1.08 encounters/recruit, respectively, men and women combined). The MP unit seen by the AT periodically had an Army medic present that treated some injuries. That medic did not record their injury encounters in the Comprehensive Injury Tracker. This may at least partly account for the lower number of MP encounters for the AT group compared to the MAT. Also, this indicates that the total encounters in MP group were somewhat underestimated.

It was possible to estimate the number of encounters per day seen by the ATs and the MAT and intervention phase by making a few assumptions. The length of the intervention period was about 8 months (about mid-May to mid-December). Assuming 20 work days/month, the total number of days was about 140 during the intervention phase. Table 21 shows the total number of encounters (men and women combined) and the estimated encounters/day. ATs and providers in the MAT saw from 3 to 13 recruits/day, on average. Providers in the MAT saw the lowest number of recruits per day. Among the ATs, the AT working with the BCT group saw the fewest recruits/day while the AT working with the ENG group saw the greatest number per day. Factors discussed above (geographic location, interaction with the units, unrecorded encounters in the MP group) likely account for the large

differences between groups and within the ATs. Although these daily numbers seem small, it should be remembered that MAT/ATs saw 32% of all medical encounters in the intervention period. Also, both the MAT and the ATs were in the units not only to provide treatment but also to observe training and to offer training and injury prevention advice to commanders and cadre.

Table 21. Estimated Encounters per Day from the Comprehensive Injury Tracker

Type of Training/Group	Group	Total Encounters (n)	Encounters /Day[a]
BCT AT	AT	488	3.5
MP AT	AT	683	4.9
ENG AT	AT	1113	8.0
BCT/MP/ENG	MAT	1749	12.5
	MAT/4[b]	1749	3.1

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group
[a]Encounters/Day=total encounters/140 days
[b]There were 4 medical care providers in the MAT and this accounts for this fact

8.2 Attrition

Findings from the attrition data were generally consistent, with some exceptions. Compared to the AT group, medical attrition was reduced to a greater extent among the MAT group for BCT men and women and male ENG recruits. Medical attrition among female MPs followed the same trend as the BCT cohort and the ENG men. Surprisingly, the male MPs in the MAT group had an increase in the proportion of medical discharges in the intervention period while the male MPs in the AT group changed little. Medical attrition was very low among the MP men in the baseline period, and it may have been difficult to further reduce attrition in this cohort. When all training types were combined (including MP training), medical attrition in the MAT group was reduced 38% among the men and 49% among the women, while that for the AT group was reduced only 14% and 11% for men and women, respectively. Thus, the reduction in medically-related attrition was greater in the MAT group than in the AT group. It should bre noted that attrition (even medical attrition) is subject to variations due to subjective, non-medical factors and overall attrition was similar.

In the present study, about 2% for BCT men and 6% of BCT women were discharged for medical reason in the baseline period and this is similar to another study we conducted in 2007 were medical discharges in BCT involved 3% of men and 9% of women.[Swedler, 2011 #3581] Previous studies have shown that attrition among recruits in BCT can be reduced by pre-BCT screening techniques or by remedial programs once recruits are in training. These techniques have been previously reviewed.[78] As noted in the introduction, the Navy developed a Sports Medicine and Rehabilitation (SMART) center for recruits at the Marine Corps Recruit Depot at San Diego. This center had a wide variety of medical care providers and

was similar in concept to the MAT, designed to bring medical care closer to the training area.[66]. One SMART center analysis (discussed in more detail in the Background section) suggested that medical attrition was reduced 57% among male recruits after initiation of the SMART clinic.[67] The present investigation had similar, albeit somewhat lower, reductions in medical attrition for the MAT group, 38% among the men and 49% among the women in the intervention period (all types of training combined). The somewhat lower reduction in the present investigation may be due to a number of factors, among which might include the nature of the training (Marines versus Army) or the greater variety of medical providers in the SMART Center.

It was possible to estimate the cost savings based on the reduction in medical attrition in the MAT and AT. In 2010 the cost from accession to graduation was estimated to be $40,298 for a BCT recruit and $54,000 for an OSUT recruit.[1] Table 22 shows the changes in medical attrition in the 3 types of training and the estimated cost savings based on these data. The "change in cost" was obtained by multiplying the cost per recruit by the number recruits who were retained or attrited. The estimated cost savings during the 8 month course of the project was $3,502,725 for the MAT group and $744,178 for the AT group (men and women combined). If these numbers were projected to the entire year by increasing the cost by 1/3 (i.e., an additional 4 months) then cost savings were estimated at $4,670,183 for the MAT group and $992,213 for the AT group.

Table 22. Cost Analysis Based on Medical Attrition Data

Type of Training	Gender	Group	Medical Discharges (%)		Change in Attrition (n/1000 recruits)[a]	Total Recruits	Change in Recruits Retained or Attrited (n)[a]	Change in Cost ($)[b]
			Baseline	Intervention				
BCT	Men	MAT	1.5	0.9	6	2,423	14.5	584,321
		AT	2.6	2.6	0	986	0.0	0
	Women	MAT	5.5	2.8	27	1043	28.2	1,136,404
		AT	6.5	4.4	21	347	7.3	293,652
MP	Men	MAT	0.8	1.9	-11	417	-4.6	-248,400
		AT	1.8	1.7	1	609	0.6	32,400
	Women	MAT	8.6	5.8	28	145	4.1	221,400
		AT	7.4	8.2	-8	233	-1.9	-102,600
ENG	Men	MAT	6.2	0.5	57	587	33.5	1,809,000
		AT	2.4	1.0	14	818	11.4	615,600
	Women	MAT	0.0	0.0	0	30	0.0	0
		AT	8.7	20.0	113	19	-2.1	-113,400
Total	Men	MAT						2,144,921
		AT						77,652
	Women	MAT						1,357,804
		AT						666,526

[a]A positive number indicates recruits retained, a negative number indicates recruits attrited
[b]The change in the number of recruits retained or lost are multiplied by $40,298 for BCT and $54,000 for OSUT

8.3 Physical Fitness

The APFT data indicated that when compared to their own baselines, the number of push-ups and sit-ups completed by MAT group recruits tended to remain the same or increase while those of the AT tended to remain the same or decrease in the intervention period. Total APFT scores reflected these findings. Two-mile run performance was generally higher in the intervention period for both the MAT and AT groups. However, the baseline performance of the MAT was lower than that of the AT group making it easier for the MAT group to show improvements. Nonetheless, when the MAT and AT groups were directly compared in the intervention period, the MAT group had higher performance on a greater number of comparisons. Although changes in the APFT scores in the intervention period were relatively small, the results suggest that the MAT was marginally more effective than the AT group in improving fitness, especially the muscular endurance measures.

The presence of the certified strength and conditioning specialist may have contributed to the greater effect on fitness for the MAT group. These individuals are certified by a number of organizations (e.g., National Strength and Conditioning Association, American College of Sports Medicine, American Council on Exercise) to conduct human performance testing, design and implement physical training programs, and provide guidance regarding nutrition and injury prevention. They are individuals who apply the principles of physical training to improve physical performance. Their major function on the MAT was to provide physical training advice to the trainers following the principles outlined in the Physical Readiness Training manual.[68] They may have been able to assure that physical training exercises were carried out in a manner to improve physical fitness. Previous investigations in BCT have shown that a standardized physical training program that enforces progressive overload, reduces long-distance running, and provides a variety of militarily-relevant training activities can substantially improve physical fitness and reduce injury rates.[34, 45, 77, 79] In addition, the strength and conditioning specialist provided some individualized training. This included training recruits in more effective ways of running including gait training, pacing techniques, and resisted running. They also instructed individual soldiers on core stabilization techniques like planks and bridges to increase sit-up performance, and isometrics and shoulder stabilization to improve push-up performance.[80, 81] The changes in APFT performance were generally small and it may be that only very small improvements can be made on the current program of physical training. Also, the small improvements in fitness were at the “cost” of having two additional personnel attached to the units. Finally, how the strength and conditioning specialist may have influenced injury rates (if at all) is not clear since the MAT and AT groups had similar injury outcomes.

There were some differences in age and physical characteristics of the men and women by phase. Notably, male recruits in the intervention phase tended to be slightly younger, lighter in weight, and had a lower BMI compared to those in the baseline phase; female recruits were younger in the intervention phase. Age, weight, and BMI have been shown to influence APFT scores in previous studies.[82-84] The average differences in the baseline to the intervention were no greater than 2.2 years, 6 lbs and 0.7 kg/m^2 for age, weight, and BMI, respectively. When these factors were controlled for in the ANCOVA, the APFT results showed virtually no change indicating that these variables had little effect on the APFT measures in the current investigation.

8.4 Physical Fitness, Age, and Physical Characteristics

Data from the present study can be analyzed to examine the influence of age, weight, and BMI on APFT scores over the broader range of these variables. Table 23 shows these data for BCT men's first APFT in the baseline phase. Age had no effect on push-up performance but there were progressive declines in sit-up and 2-mile run performance with progressing age. These data are consistent with a previous report examining age in relation to APFT events in a large cohort of recruits in BCT.[85] Higher body weight was associated with lower performance in all 3 APFT events. BMI showed a pattern that differed from weight. Recruits with the lowest BMI (<18.5 kg/m^2) had lower performance than those in the normal BMI category (18.5-24.9 kg/m^2). Performance was highest in the normal BMI category, lower in the overweight (25.0-29.9 kg/m^2) category, and lower again in the obese (≥ 30 kg/m^2) category.

Table 23. Influence of Age, Weight, and BMI on Final APFT Scores among BCT Men in the Baseline Phase

Variable	Strata	Push-Ups		Sit-Ups		2-Mile Run	
		N	M±SD	N	M±SD	N	M±SD
Age	<20 years	1088	52±13	1089	63±11	1081	14.8±1.4
	20.0-24.9	1662	53±14	1662	62±11	1651	14.9±1.5
	25.0-29.9	509	53±14	509	60±12	506	15.1±1.4
	≥30.0	311	52±15	3571	57±13	311	15.5±1.6
	p-value	0.29		<0.01		<0.01	
Weight	<70.3 kg	871	56±14	872	64±11	869	14.5±1.4
	70.3-78.0	819	55±14	820	63±11	815	14.6±1.5
	78.1-88.0	848	52±13	848	61±12	847	15.0±1.4
	≥88.1	882	48±12	881	58±11	872	15.6±1.5
	p-value	<0.01		<0.01		<0.01	
BMI	<18.5 kg/m^2	50	50±13	50	61±11	50	14.9±1.4
	18.5-24.9	1701	55±14	1703	64±12	1697	14.5±1.4
	25.0-29.9	1432	52±13	1431	60±11	1418	15.2±1.4
	≥30	369	49±12	369	57±11	367	15.8±1.4
	p-value	<0.01		<0.01		<0.01	

Abbreviations: BMI=body mass index; M=mean; SD=standard deviation

The J-shaped relationship between BMI and performance on the APFT is interesting and deserves further comment. Besides the well established relationship between BMI and body fat,[71, 86, 87] BMI also shares some relationship with fat-free mass. The correlations between fat-free mass and BMI was 0.71 in a study of Army wheel vehicle mechanics[88] and unpublished results from a study of male basic trainees found a correlation of 0.64.[89] Very low BMI may reflect a paucity of muscle mass (in addition to low bone and fat mass) and this could affect the ability to perform the APFT events. This effect may be less on the 2-mile run where individuals are required to move their entire body and thus lower total body weight may be advantageous for completing the distance in a shorter period of time.

There are few studies that have examined the association between BMI and fitness among men in an age range similar to that of the present investigation. A previous study of men in a Finnish Army refresher course (aged 29±4 years) showed that maximal oxygen consumption (cycle ergometer heart rate estimate) and push-up and sit-up performance decreased from normal to obese BMI.[90] Another study examined highly active German men applying to flight school (aged 18-23 years) who had BMIs between 19.7 and 25.0 kg/m^2. The authors found that physical work capacity (PWC170, a measure of cardiorespiratory endurance) decreased with increasing BMI even in this narrow BMI range.[91] Data from these two studies are consistent with those of the present study in the normal to obese range. However, they did not examine those with very low BMI (<18.5 kg/m^2).

Studies of children and adolescents have generally found an "J"-shaped relationship between BMI and performance on tests of muscular endurance and cardiorespiratory fitness such that performance is highest among those of normal BMI and lower among those who are underweight, overweight or obese.[92, 93] There were no studies of individuals in the age range here that examined the influence of low BMI on measures of physical fitness.

8.5 Injury Risk Factors

The results from the risk factor analysis (Cox regression) were relatively consistent across groups and types of training showing that injury risk was associated with older age, cigarette smoking prior to BCT, lower levels of physical activity prior to BCT, prior lower limb injury, and abnormal menses.

8.5.1 Age

Older age increased injury risk in virtually all types of training and in both groups, but the relationship was not necessarily linear. Nonetheless, in all types of training and for both groups, risk was substantially elevated in the oldest age group (≥30 years) compared to the youngest (<20 years). Other BCT investigations have also shown

older age as a injury risk factor.[5, 15, 31, 38, 47] However, this finding contradicts studies of infantry Soldiers[94] and studies with predominately infantry Soldiers[95] that have shown younger Soldiers to have higher risk than those who are older. One possible explanation[94] might be that, in the infantry, younger Soldiers may perform more of the arduous occupational tasks and thus be more susceptible to injury than older Soldiers, who are likely to be of higher rank and working in supervisory or staff positions. BCT training differs from the operational infantry in that all individuals perform the same physical training tasks. Under these conditions older individuals appear to be more susceptible to injury.

The reason for the higher susceptibility to injury in older individuals may have to do with age-related changes in stem cells, declines in fitness, and/or prior injury history. First, consider changes in stem cells. Older tissues have less regenerative capability, due at least partially to age-related declines in the ability of resident stem cells to initiate and conduct tissue repair.[96-98] This could make older individuals more susceptible to overuse-type injuries in which microtrauma accumulates over time and repair in the older tissue does not keep pace with repeated microtraumas.

Besides age-related declines in stem cells, fitness declines with age as shown in Table 23. Aging results in a loss of muscle mass, muscle strength, muscular endurance, aerobic capacity, and flexibility.[82, 99] The loss of aerobic capacity and muscular endurance can begin as early as 25 years of age.[82] These age-related changes reduce absolute fitness levels and may make injuries more likely since lower fitness has been shown to be consistently related to injury.[13, 15, 29, 30, 37, 40, 47-49, 100-105]

Besides stem cell changes and lower fitness levels with age, prior injuries may play a role in the association between age and BCT-related injuries. It is possible that older individuals are more likely to have prior injuries because of their longer time at risk and this could make them more susceptible to future injuries. Prior injuries have been shown to be a risk factor for new injuries in many studies including the current one.[102, 106-116] To examine the hypothesis that prior injuries may make older recruits more susceptible to injuries in training, self-reported prior lower limb injuries were stratified by age for BCT recruits in the baseline phase. These data are shown in Table 24. There was a trend indicating that those reporting a prior injury had more injuries in training, but this evidence was not strong or consistent across all age groups. This finding is similar to that found among individuals in Federal Bureau of Investigation new agent training.[117]

Table 24. Injuries in Training Stratified by Self-Reported Prior Injury and Age for BCT Recruits in the Baseline Phase

Gender	Response Category	<20 Years		20.0-24.9 years		25.0-29.9 years		≥30 years	
		N	Injured in Training (%)	N	Injured in Training (%)	N	Injured in Training (%)	N	Injured in Training (%)
Men	No Reported Prior Injury	902	23.8	1341	26.5	411	27.5	263	38.4
	Reported Prior Injury	265	29.9	416	29.1	131	37.4	79	43.0
	Risk Ratio (95%CI)	1.25 (1.01-1.56)		1.10 (0.93-1.31)		1.36 (1.04-1.78)		1.12 (0.83-1.51)	
	p-value[a]	0.05		0.30		0.03		0.46	
Women	No Reported Prior Injury	301	56.1	418	59.8	107	52.3	86	68.6
	Reported Prior Injury	104	60.6	91	70.3	35	62.9	13	69.2
	Risk Ratio (95%CI)	1.08 (0.90-1.30)		1.18 (1.01-1.37)		1.20 (0.88-1.64)		1.01 (0.68-1.49)	
	p-value[a]	0.43		0.06		0.28		0.96	

Abbreviation: CI=confidence interval
[a]Chi-square statistic

8.5.2 Body Mass Index

Very low (<18.5 kg/m^2) and obese BMI (>30.0 kg/m^2) was generally associated with higher injury incidence among the men, but BMI showed little association with injuries among women in the present study. The results of previous basic training studies conflict with regard to associations between BMI and injury. A previous Marine Corps basic training study showed that women with either high or low BMI were at higher risk of stress fractures (bimodal relationship), but no relationship was found for overuse injuries exclusive of stress fractures.[118] A study examining all Army BCT stress fractures between 1997 and 2007 found that both men and women with very low BMI were at elevated risk relative to those of normal BMI, but only men had elevated risk at very high BMI.[119] Some Army and Air Force basic training studies have reported bimodal relationships,[13, 39] but others have shown no relationship[15, 31] or increased risk with higher BMI.[120] One study of the Chinese Armed Forces Police found that those with low BMI were at higher injury risk.[121]

Generally, BMI shows a close relationship with body fat in military and civilian samples, demonstrating correlations on the order of 0.7.[71, 86, 88] However, this means that only about 50 percent of the variance in BMI is accounted for by body fat. The relationship between BMI and injury in basic training is likely to be complex because individuals can have a high BMI either because of higher body fat or

because of higher fat-free mass. If high BMI reflects a larger percentage of body fat relative to height, injury risk might be increased because the additional fat burden would increase the intensity of physical activity[122] leading to more rapid fatigue and impose additional repetitive stress on the musculoskeletal system because of the greater weight relative to height. However it should be noted that body fat *per se* has not shown a consistent relationship with injuries in Army BCT.[13, 15, 30] In contrast to high BMI, low BMI may reflect a paucity of either fat, fat-free mass, or both, as noted above. Low BMI may make recruits more susceptible to injury if they lack the muscle mass or strength in the supportive structures (ligaments, bones) required to perform certain physical tasks and/or if they overexert or overuse the available muscle mass or supportive structures. In light of these considerations and since a number of studies have shown that high, low, or both high and low BMI are associated with injury in basic training,[13, 30, 39, 40, 118-120] a bimodal relationship may be most plausible.

8.5.3 Cigarette Smoking

In the present study, there were strong associations between cigarette smoking and higher injury incidence for all types of training, both groups, and among both men and women. Generally, individuals who reported smoking 100 cigarettes in their life or had started smoking earlier in their life had higher injury risk. Similarly, those who reported smoking in the 30 days before basic training tended to have higher injury risk and in BCT where the sample size was larger, there was a dose-response such as the number of cigarettes smoked, injury risk increased. Cigarette smoking prior to basic training has consistently been associated with increased injury risk in US Army and Air Force basic training[15, 31, 39, 40, 123, 124] and in army basic training in other countries.[47, 125] Further, smoking has been associated with injury in infantry soldiers[126] and in other occupational groups.[127-134] Past BCT studies have demonstrated the same dose-response seen in the BCT group in the present study.[15, 31, 39, 40, 47, 123]

With regard to the possible mechanisms and the biological plausibility of the association between injury risk and cigarette smoking, there is considerable evidence showing that cigarette smoking impairs wound healing,[135-139] bone healing,[140-145] tissue strength,[146-151], and immune function.[145] The immune system is important for tissue healing, since macrophages, leukocytes, and lymphocytes regulate various steps in the process and remove or assist in removal of damaged tissue.[145, 152-155] The macrophages of smokers have lower phagocytic activity, lower responsiveness to bacterial challenge, and reduced gene expression of the proinflammatory cytokines, the latter of which are important for tissue healing.[156-158]

Collagen deposition is a major factor in wound healing.[159, 160] Shortly after an injury, fibroblasts migrate to the site of the injury to synthesize and deposit a matrix

composed of collagen on which glycoproteins form. [145, 161] In cell preparations, cigarette smoke extracts have been shown to reduce collagen content; decrease fibroblast recruitment, proliferation, migration, and contraction; lead to delayed wound closure; and reduce the amount of new tissue formation.[148-151] In one study, damage to the medial collateral ligament resulted in less cellular density and reduced expression of Type I collagen in mice exposed to cigarette smoke for 2 months.[147] Human studies involving experimentally induced arm wounds showed that smokers produced less hydroxyproline, a marker of collagen production,[162, 163] and synthesized less Type I and Type III collagen.[164] Non-collagen protein was apparently not affected.[163] The metabolic pathway for collagen deficit in smokers may involve reduced conversion of proline to hydroxyproline, since this pathway requires molecular oxygen and smokers exhibit reduced tissue oxygenation.[165]

In basic training, all recruits are required to cease smoking at the beginning of training. Thus, the mechanism accounting for the association between smoking and injuries must be active beyond cessation of smoking, into the BCT/OSUT period. Evidence for the longer-term effects of smoking come from studies on collagen metabolism, skin damage, immune function, and possibly, bone tissue. One study[166] followed weekly urinary hyrdoxyproline/creatine levels (indicative of collagen metabolism) from individuals 14 weeks after they ceased smoking. It was estimated (by mathematical modeling) that hydoxyproline/creatine levels would return to the level of nonsmokers in about 71 weeks, among those who had previously smoked ≤ 40 cigarettes/day, while it would take 120 weeks to reach the same level in those who had been smoking > 40 cigarettes/day. Smoking reduction (by at least 50 percent) for 6 to 8 weeks prior to surgery has been shown to be associated with a reduction in postsurgical complications.[167] Immune studies suggest that smoking-induced leukocytosis slowly decreases over time once smoking ceases.[168-174] One day to 6 weeks after smoking cessation, the leukocyte count was still elevated.[170, 174] Three months after smoking cessation, the neutrophil concentration tended to decrease.[169] Leukocyte counts approached the level of nonsmokers the longer it had been since the individual stopped smoking, but men who had quit smoking for 10 years or more still had higher leukocyte counts than nonsmokers in one study.[171] Another investigation showed that men and women who had quit smoking for an average of 11 years had counts similar to those who had never smoked.[168]

Besides physiological mechanisms, psychosocial factors can also be considered in accounting for the association between cigarette smoking and injury. Air Force recruits who were cigarette smokers had higher scores than nonsmokers on various measures of risk taking. These included greater rebelliousness, less seat belt use, more risky sex, more favorable views of illegal drug use, more alcohol use, more binge drinking, less physical activity, less intake of fruits and vegetables, and greater intake of high-fat foods. An overall measure of risk taking was also higher in these Air Force recruit smokers.[175] In civilian studies, smokers had more motor vehicle

accidents, had more traffic violations, used seat belts less often, participated in less physical activity, consumed more alcohol, and had lower intake of fruits and vegetables.[176-178] Heavy smoking (≥ 20 cigarettes/day) is much more likely to be associated with multiple risk behaviors.[178] It is possible that this higher risk-taking behavior of smokers manifests itself in the activities of basic training and results in a higher injury rate among smokers.

Whether physiological or psychosocial explanations are a more plausible mechanism to explain the association between injuries and smoking will have to await further investigation. It is likely that a combination of these factors may be involved

8.5.4 Physical Activity

Six items on the questionnaire dealt with physical activity prior to basic training. These included 1) a self assessment of physical activity, 2) a general sports and exercise question, 3) a running frequency question, 4) a running history question, 5) a weight training frequency question, and 6) a question on weight training history. Men and women who had a lower self-rating of physical activity were at higher risk of injury and a dose-response was generally evident in both groups and in all types of training for both men and women. This identical question has been used in a previous BCT investigation and in studies of Marine Corps and Air Force basic training, and in most of these studies a dose-response was also evident.[5, 73] Previous studies that used similar self-assessments have also reported strong relationships with injuries.[13, 31, 38]

Men and women who reported a lower frequency of exercise/sports, or a lower frequency running/jogging in the two months prior to basic training were at higher injury risk. There was also an association between weight training frequency and injuries among the BCT men but the association was much weaker within the other types of training or among the women in general, regardless of training. The two questions on exercise history (length of time running/jogging or weight training) showed a dose-response for all groups, all types of training, and for both men and women: a shorter history of training was generally associated with higher injury risk. Other studies of Army and Marine Corps recruits have shown that lower pre-basic training physical activity increases injury risk in training.[13, 15, 31, 38, 39, 47, 101, 102, 121] In Army basic training, recruits perform weight-bearing physical activity primarily in the form of standing (in formation), walking, marching in cadence, and running.[179] It seems reasonable that a longer history or a higher recent frequency of weight-bearing physical training prior to basic training (as reflected by questions on general exercise/sports or running/jogging) would result in less susceptibility to injury because of the favorable influences of physical activity on the body. Physical activity of the proper intensity, frequency, and duration can increase aerobic fitness, muscle

strength, connective tissue strength, and general health, and can reduce body fat.[75, 180-186] Bone mineral density is higher in physically active individuals[124, 187-191] and higher bone mineral density has been associated with greater weekly physical activity.[189] These and other factors may contribute to reducing susceptibility to injury among recruits.[192] Individuals with a longer history of training would be expected to have more time to develop these favorable adaptations.

8.5.5 Prior Injury

A self-reported prior lower limb injury was generally an injury risk factor for all types of training, both groups, and for men and women. Injury risk was even higher if recruits reported that the prior injury had limited activity for at least 1 week, and especially if they reported that they had not totally recovered from the injury. This finding is not in consonance with previous investigations in BCT that found little association between prior injuries when the question was posed in a different manner [31, 48, 101, 193] or identically.[5, 72, 73] Despite this, studies of other military groups,[107, 108, 113] athletes,[109-112, 114-116, 118] and industrial workers[106] have reported that prior injuries were associated with current injuries, especially if an injury had occurred in the preceding year.[110, 111, 114-116] The reasons for this difference are not clear.

As to the mechanisms to account for the association between prior injury and injuries in training, some authors have speculated that contractile or connective scar tissues may alter movement mechanics, or that muscle tissue atrophy induced by some injuries might reduce strength or result in muscle imbalances[194] that could affect injuries.[195-197] A recent study of athletes with prior hamstring injuries (5 to 13 months ago) found larger biceps femoris muscle mass in the previously injured limb (compared to the uninjured) but there were no differences between limbs on isokinetic strength (60 deg/sec), running kinematics, or muscle activation.[198]

8.5.6 Abnormal Menses

The current study found that women reporting no menstrual periods in the last year, or had gone ≥6 months without a cycle were generally at higher injury risk. Past studies in Army, Air Force, and Marine Corps basic training have shown similar results.[5, 72, 73, 102, 199] Surveys of young (average 26 years) active duty Army women[200] and women in Marine Corps Officer Candidate School[201] have shown menstrual irregularities to be associated with higher stress fracture incidence. Besides military studies, investigations of female athletes have also suggested that those with menstrual irregularities have a higher overall injury incidence,[202] have a higher incidence of stress fractures and frank fractures,[202-204] and take longer to recover from injuries.[205] It has been hypothesized that amenorrhea results in hormonal changes, especially lower estrogen levels, which leads to a reduction in

bone mineral density and increasing likelihood of fracture.[202, 204-206] However, others[207] have cautioned that athletes with menstrual disturbances also have other risk factors like greater training loads, lower calcium intake, and differences in soft tissue composition. In BCT and OSUT, the training load is similar for all recruits and all recruits have access to the same calcium sources in the mess hall. Nonetheless, in a BCT study in 1993, calcium intake of recruits was only 73 percent of the Military Recommended Daily Allowance.[37] One study found that amenorrheic women had lower bone mineral density even after controlling for calcium intake.[204]

8.5.7 Prior Pregnancy

In the present investigation, those who had previously been pregnant were at higher injury risk, especially if that pregnancy was ≥13 months ago. Previous BCT investigations have had mixed results as to the association of prior pregnancy on injury risk. One prior study showed no effect.[48] but a more recent study that asked the question in the identical manner as the present investigation showed that the longer time since the last pregnancy, the higher the injury risk.[39] Studies in Air Force and Marine Corps basic training showed little association but the number of prior pregnant women in these latter two studies were small.[40, 73]

One possible mechanism that may account for the association between pregnancy and injury risk is joint laxity. During pregnancy, relaxin acts in concert with estrogen to increase ligament laxity by reducing the density of collagen fiber bundles. [208] This could increase the likelihood of ligament injury due to excessive joint flexibility.[209, 210] However, the highest levels of relaxin occur in the first trimester of pregnancy and relaxin levels decline for the rest of pregnancy with no ante partum surge, although it continues to be released by the corpus luteum throughout pregnancy.[208] Joint relaxation in the symphysis pubis increases during pregnancy but returns to baseline 3 to 5 months post delivery.[210] Thus, it seems unlikely that joint laxity accounts for the relationship between prior pregnancy and injury. Some longer-term effects of pregnancy cannot be altogether ruled out.[210]

It seemed possible that prior pregnancy covaried with age, because those who had been pregnant ≥12 months ago were also likely to be older, and older age was strongly associated with injury in the present study. Table 25 shows injury incidence with pregnancy history, stratified by age for BCT recruits in the baseline phase. The two younger age groups were combined to increase statistical power. Among the two younger age groups there was little or no elevated risk among those who had been pregnant. However, at the older age group, those who had been pregnant were at higher risk. This suggests that pregnancy has little effect on injury risk at younger ages but may increase risk at older ages (≥ 25 years).

Table 25. Injuries Stratified by Self Reported Prior Pregnancy and Age for BCT Recruits in the Baseline Phase

Response Category	<20 Years		20.0-24.9 years		≥25.0years	
	N	Injured in Training (%)	N	Injured in Training (%)	N	Injured in Training (%)
Never Pregnant	370	56.8	410	61.0	84	44.0
Prior Pregnancy	35	62.9	99	64.6	59	71.2
Risk Ratio (95%CI)	1.11 (0.85-1.34)		1.06 (0.68-1.21)		1.35 (1.09-1.67)	
p-value[a]	0.49		0.50		<0.01	

Abbreviation: CI=confidence interval
[a]Chi-square statistic

9 CONCLUSIONS AND RECOMMENDATIONS

There were few differences between the MAT and AT groups in terms of the injury outcomes: both groups demonstrated similar reductions in the proportion of injured recruits and in the number of injury encounters seen in the clinic/hospital during the intervention period. Despite the reduction in the number of injured recruits, the total number of injury encounters (clinic/hospital encounters plus AT/MAT encounters) increased in both groups, likely because of the more convenient access to medical care provided by the MAT/AT. In terms of medical attrition, there was a greater reduction in the MAT group. In terms of physical fitness, improvements in the intervention period were greater in the MAT group than in the AT group when the groups were compared to their respective baselines, although these performance increases were small. When the MAT and AT group were directly compared in the intervention period, the MAT had higher performance in a greater number of comparisons. Based on these data, it is recommended that the MAT group model be favored over the AT group model, primarily because of more favorable changes in attrition.

If the MAT or AT models are implemented, there needs to be continued accountability for recording all visits through the Comprehensive Injury Tracker or similar mechanisms. Cost and manpower effectiveness of such imbedded medical assets need to be calculated. Although the MAT and ATs accounted for about 1/3 of the medical visits, the encounters/day were low suggesting that these models of care may be clinically inefficient, although the MAT and ATs also provided injury prevention advise to the cadre that may not be reflected in the data collected. In terms of attrition prevention and fitness enhancement, it may be effective to utilize other non-medical experts, such as those graduating from the newly developed Army Master Fitness Trainer course.

Further follow-up should be performed on units that have ATs and MATs. This study covered a period when the ATs and MAT had just arrived at Fort Leonard Wood. Lessons learned here and the experiences of the ATs and MATs will likely be used to modify how the ATs and MAT operate. Outcomes may be different in the longer term.

10 POINTS OF CONTACT

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Appendix A

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Appendix B

Questionnaire

New Soldier Survey

PLEASE READ ALL DIRECTIONS AND QUESTIONS CAREFULLY.

- **Answer all questions to the best of your recollection.**
- **Fill circles in completely.**
- **Ask the staff for help if you need it.**

About You

1. Today's date:

   |___|___| / |___|___| / |___|___|___|___|
   MONTH DAY YEAR

2. What is your birth date?

   |___|___| / |___|___| / |___|___|___|___|
   MONTH DAY YEAR

3. What is your SSN?

   |___|___|___|-|___|___|-|___|___|___|___|

4. What is your name?

   _____
   (LAST NAME, FIRST NAME, MIDDLE INITIAL)

5. Are you…

   O Male
   O Female

6. What is your height? |___| feet |___|___| inches

7. What is your weight? |___|___|___| pounds

Tobacco Use

8. Have you smoked at least 100 cigarettes in your life? (100 cigarettes = 5 packs)

   O YES
   O NO

9. About how old were you when you smoked a whole cigarette for the first time?
   (If you have never smoked a whole cigarette, write 00)

   |___|___| Years Old

10. In the 30 days just before basic training, on how many days did you smoke a cigarette?
    (If you have never smoked or did not smoke in the 30 days before basic training, write 00)

    |___|___| Days

11. On the days you smoked in the 30 days before basic training, how many cigarettes did you smoke per day, on average?
    (If you have never smoked or did not smoke in the 30 days before basic training, write 00)

    |___|___| Cigarettes

12. If you used to smoke cigarettes and quit, how long ago did you quit?
    (If you have never smoked or are a current smoker, write 00 in both locations)

    |___|___| Months or |___|___| Years

13. In the 30 days before basic training, on how many days did you use smokeless tobacco (chewing, snuffing, pinching, etc)?
    (If you did not use smokeless tobacco in the 30 days before basic training, write 00)

    |___|___| days

14. On the days you used smokeless tobacco in the 30 days before basic training, how many cans, pouches, or plugs did you use per day, on average?
(If you did not use smokeless tobacco in the 30 days before basic training, write 0)

|____| cans, pouches, or plugs

Physical Activity

15. Compared to others your same age and sex, how would you rate yourself as to the amount of physical activity you performed prior to entering basic training?
O Much less active
O Somewhat less active
O About the same
O Somewhat more active
O Much more active

16. In the 2 months before basic training, what was the average number of **times per week** you exercised or played sports for at least 30 minutes at a time?

O Never
O Less than 1 time per week
O 1 time per week
O 2 times per week
O 3 times per week
O 4 times per week
O 5 times per week
O 6 times per week
O 7 times or more per week

17. In the 2 months before basic training, how many **times per week** did you run or jog?

O Never
O Less than 1 time per week
O 1 time per week
O 2 times per week
O 3 times per week
O 4 times per week
O 5 times per week
O 6 times per week
O 7 times or more per week

18. For how many months were you running or jogging before you entered basic training?

O Did not run or jog
O 1 month or less
O 2 months
O 3 months
O 4 to 6 months
O 7 to 11 months
O 1 year or more

19. In the 2 months before basic training, how many **times per week** did you perform weight training exercises?

O Never
O Less than 1 time
O 1 time
O 2 times
O 3 times
O 4 times
O 5 times
O 6 times
O 7 times or more

20. If you performed weight training in the 2 months before basic training, how long have you been doing this?

O Did not weight train
O 1 month or less
O 2 months
O 3 months
O 4 to 6 months
O 7 to 11 months
O 1 year or more

Injury History

21. Prior to basic training, had you ever injured bone, muscle, tendon, ligaments, and/or cartilage in one or both of your lower limbs, ankles, or feet?

    O YES
    O NO

22. Did any of these injuries prevent you from participating in your normal physical activities for at least one week?

    O Does not apply, never been injured
    O YES
    O NO

23. Following these injuries, were you able to eventually return to 100% of your normal physical activities?

    O Does not apply, never been injured
    O YES
    O NO

If you are a **man**, stop here and wait for further instructions.

If you are a **woman**, complete questions 24 through 28 on the following page.

Women Only: Menstrual History

24. At what age did you start to menstruate?
(If you have not had a menstrual cycle, write 00)

|___|___| Years

25. Over the last 12 months, how many menstrual periods did you have?
(If you have not had a menstrual period, write 00)

|___|___| Menstrual Periods

26. During the last 12 months, have you ever missed six or more months in a row between menstrual cycles?

O I have never had a menstrual period
O No, I have never missed 6 or more months in a row between menstrual cycles
O Yes, I have missed 6 or more months in a row between menstrual cycles

27. In the last 12 months, have you taken birth control pills or any other hormonal therapy?

O YES
O NO

28. If you have ever been pregnant, how many months or years ago were you last pregnant?
(If you have never been pregnant, write 00 in both locations)

|___|___| Months or |___|___| Years

Stop here and wait for further instructions.

Appendix C
Other Data from the Comprehensive Injury Tracker

Table C1 shows the activities associated with injuries in the Comprehensive Injury Tracker. Many injuries had a gradual onset and could not be associated with a specific activity. Where the recruit was able to provide an activity, physical training, road marching, and the confidence/obstacle course accounted for the largest proportions of the injuries.

Table C1. Activities Associated with Injury in Comprehensive Injury Tracker

Gender	Activity	MAT						AT					
		BCT		MP		ENG		BCT		MP		ENG	
		N	%	N	%	N	%	N	%	N	%	N	%
Men	Gradual Onset	52	25.6	37	25.9	18	22.5	58	34.1	84	39.6	540	81.2
	Physical Training	79	38.9	64	44.8	40	50.0	20	11.8	10	4.7	12	1.8
	Fitness Testing	2	1.0	0	0.0	0	0.0	2	1.2	2	0.9	1	0.2
	Sports	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2
	Boots	0	0.0	0	0.0	0	0.0	0	0.0	6	2.8	0	0.0
	Road Marching	18	8.8	16	11.2	4	5.0	65	38.2	41	19.3	20	3.0
	Rifle Marksmanship	3	1.5	0	0.0	0	0.0	0	0.0	2	0.9	0	0.0
	Victory Tower	0	0.0	0	0.0	1	1.3	0	0.0	4	1.9	3	0.5
	Pugil Stick	0	0.0	0	0.0	0	0.0	0	0.0	3	1.4	4	0.6
	Combatives	5	2.4	0	0.0	1	1.3	3	1.8	3	1.4	3	0.5
	Confidence/Obstacle Course	15	7.3	14	9.8	6	7.5	3	1.8	11	5.2	26	3.9
	Barracks	11	5.4	4	2.8	3	3.8	0	0.0	8	3.8	27	4.1
	Corrective Training	4	2.0	1	0.7	0	0.0	2	1.2	4	1.9	5	0.8
	Land Navigation	1	0.5	3	2.1	4	5.0	1	0.6	2	0.9	3	0.5
	Victory Force - Field Training	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	3	0.5
	Grenade Range	2	1.0	1	0.7	0	0.0	0	0.0	0	0.0	0	0.0
	Unsure	5	2.4	1	0.7	1	1.3	0	0.0	6	2.8	4	0.6
	Other	6	3.0	2	1.4	2	2.5	15	8.8	26	12.3	13	2.0
Women	Gradual Onset	102	32.5	44	26.5	8	27.6	61	40.9	81	39.1	28	82.4
	Physical Training	104	33.1	53	31.9	12	41.3	13	8.7	4	1.9	0	0.0
	Fitness Testing	6	1.9	1	0.6	0	0.0	2	1.3	1	0.5	0	0.0
	Sports	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Boots	1	0.3	1	0.6	0	0.0	0	0.0	11	5.3	0	0.0
	Road Marching	46	14.6	30	18.1	5	17.2	54	36.2	39	18.8	2	5.9
	Rifle Marksmanship	0	0.0	2	1.2	0	0.0	0	0.0	2	1.0	0	0.0
	Victory Tower	0	0.0	0	0.0	0	0.0	1	0.7	3	1.4	0	0.0
	Pugil Stick	0	0.0	2	1.2	0	0.0	0	0.0	3	1.4	0	0.0
	Combatives	5	1.6	3	1.8	0	0.0	3	2.0	2	1.0	0	0.0
	Confidence/Obstacle Course	18	5.7	17	10.2	2	6.9	2	1.3	20	9.7	1	2.9
	Barracks	13	4.1	1	0.6	1	3.4	0	0.0	6	2.9	1	2.9
	Corrective Training	3	1.0	2	1.2	0	0.0	0	0.0	2	1.0	2	5.9
	Land Navigation	4	1.3	4	2.4	0	0.0	0	0.0	2	1.0	0	0.0
	Victory Force - Field Training	0	0.0	1	0.6	0	0.0	1	0.7	0	0.0	0	0.0
	Grenade Range	4	1.3	1	0.6	1	3.4	0	0.0	0	0.0	0	0.0
	Unsure	3	1.0	2	1.2	0	0.0	0	0.0	8	3.9	0	0.0
	Other	5	1.6	2	1.2	0	0.0	12	8.1	23	11.1	0	0.0

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group

Table C2 shows the frequency of injury encounters by anatomical location. The anatomic locations with the greatest proportion of injuries was the knee, foot, and ankle. Among the men, these accounted for 23%, 22% and 12% of all encounters, respectively. Among the women, these three anatomical locations accounted for 24%, 19% and 17% of all encounters, respectively. Lower extremity problems (including the lower back) accounted for 81% of male encounters and 90% of female encounters.

Table C2. Anatomical Locations of New Injuries in Comprehensive Injury Tracker

Gender	Activity	MAT						AT					
		BCT		MP		ENG		BCT		MP		ENG	
		N	%	N	%	N	%	N	%	N	%	N	%
Men	Head	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0
	Face	0	0.0	0	0.0	0	0.0	0	0.0	2	0.8	1	0.2
	Neck	1	0.5	0	0.0	1	1.3	4	2.4	1	0.4	1	0.2
	Chest	1	0.5	1	0.7	0	0.0	0	0.0	1	0.4	1	0.2
	Abdomen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.3
	Upper Back	3	1.5	2	1.4	2	2.5	2	1.2	7	2.8	6	0.9
	Lower Back	8	3.9	5	3.5	5	6.3	4	2.4	5	2.4	23	3.5
	Shoulder	8	3.9	6	4.2	2	2.5	5	3.0	11	4.3	33	5.0
	Elbow	1	0.5	0	0.0	1	1.3	1	0.6	4	1.6	4	0.6
	Arm	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4	2	0.3
	Wrist	3	1.5	1	0.7	0	0.0	2	1.2	3	1.4	16	2.4
	Hand/Finger	1	0.5	2	1.4	0	0.0	0	0.0	9	3.6	15	2.3
	Hip	13	6.4	10	7.0	5	6.3	7	4.1	6	2.4	49	7.4
	Thigh	10	4.9	1	0.7	2	2.5	8	4.7	46	18.2	15	2.3
	Knee	66	32.4	53	37.1	34	42.5	38	22.5	46	18.2	135	20.3
	Leg	26	12.7	19	13.3	9	11.3	14	8.3	22	8.7	94	14.1
	Ankle	38	18.6	23	16.1	9	11.3	28	16.6	31	12.3	68	10.2
	Foot/Toe	25	12.3	20	14.0	9	11.3	56	33.1	57	22.5	200	30.1
	Other	0	0.0	0	0.0	1	1.3	0	0.0	0	0.0	0	0.0
Women	Head	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Face	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Neck	2	0.6	1	0.6	0	0.0	2	1.3	0	0.0	0	0.0
	Chest	0	0.0	2	1.2	0	0.0	0	0.0	4	1.9	0	0.0
	Abdomen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Upper Back	7	2.2	4	2.4	0	0.0	3	2.0	2	1.0	0	0.0
	Lower Back	15	4.8	8	4.8	3	10.3	3	2.0	9	4.3	1	2.9
	Shoulder	8	2.6	4	2.4	1	3.4	6	3.9	10	4.8	2	5.9
	Elbow	2	0.6	2	1.2	0	0.0	0	0.0	2	1.0	0	0.0
	Arm	1	0.3	2	1.2	0	0.0	0	0.0	1	0.5	0	0.0
	Wrist	1	0.3	3	1.8	0	0.0	1	0.7	2	1.0	1	2.9
	Hand/Finger	2	0.6	1	0.6	0	0.0	0	0.0	7	3.4	1	2.9
	Hip	39	12.5	22	13.2	3	10.3	18	11.8	20	9.7	9	26.5
	Thigh	11	3.5	4	2.4	1	3.4	2	1.3	2	1.0	0	0.0
	Knee	96	30.8	52	31.1	10	34.5	33	21.7	29	14.0	3	8.8
	Leg	38	12.2	15	9.0	2	6.9	8	5.3	17	8.2	4	11.8
	Ankle	54	17.3	27	16.2	5	17.2	22	14.5	45	21.7	0	0.0
	Foot/Toe	33	10.6	17	10.2	3	10.3	52	34.2	57	27.5	13	38.2
	Other	3	0.9	3	1.8	1	3.4	2	1.3	0	0.0	0	0.0

Abbreviations: BCT=Basic Combat Training; MP=military police training; ENG=engineer training; AT=athletic trainer group; MAT=musculoskeletal action team group

Appendix D
Supplementary Analyses

There were some differences in the age, body weight and BMI of the recruits by group and intervention (See Table 3). An analysis of covariance (ANCOVA) was performed on the final APFT scores to control for these factors. Tables D1 shows the analysis controlling for age, Table D2 shows the analysis controlling for body mass, and Table D3 shows the analysis controlling for BMI. Tables D1 to D3 show that age, weight, and BMI had very little effect on the p-values. The adjusted means are very close to the means calculated directly from the obtained data (compare to Table 20 or Table 21).

Table D1. Comparison of Final APFT Scores by Group and Intervention While Controlling for Age

Type of Unit	Gender	Event	Phase	MAT		AT		ANCOVA p-values		
				N	Adjusted Mean (reps, min, or points)	N	Adjusted Mean (reps, min, or points)	Group	Phase	Group X Phase
BCT	Men	PU	Baseline	2616	53	954	53	0.30	0.56	0.31
			Intervention	2275	53	928	54			
		SU	Baseline	2616	61	955	64	0.84	0.85	<0.01
			Intervention	2274	63	928	61			
		2-Mile Run	Baseline	2605	14.9	944	14.8	0.19	0.18	0.05
			Intervention	2270	14.7	926	14.4			
		Total Points	Baseline	2591	223	943	230	0.22	0.32	0.11
			Intervention	2266	228	926	231			
	Women	PU	Baseline	681	31	276	31	0.94	0.54	0.32
			Intervention	896	32	294	31			
		SU	Baseline	680	57	276	61	0.72	0.99	<0.01
			Intervention	895	60	294	59			
		2-Mile Run	Baseline	680	18.0	270	17.6	0.34	0.34	0.10
			Intervention	891	17.6	293	17.5			
		Total Points	Baseline	673	218	270	228	0.43	0.57	0.02
			Intervention	886	226	293	227			
MP	Men	PU	Baseline	699	57	1265	62	0.31	0.80	<0.01
			Intervention	378	58	552	60			
		SU	Baseline	699	69	1265	72	0.47	0.97	<0.01
			Intervention	378	70	553	70			
		2-Mile Run	Baseline	621	14.1	1265	14.0	0.80	0.31	0.04
			Intervention	378	13.8	552	13.9			
		Total Points	Baseline	609	247	1264	256	0.44	0.71	<0.01
			Intervention	369	253	550	254			
	Women	PU	Baseline	184	36	315	43	0.66	0.97	<0.01
			Intervention	115	41	178	39			
		SU	Baseline	184	67	315	72	0.51	0.84	0.01
			Intervention	115	69	179	69			
		2-Mile Run	Baseline	165	16.8	314	16.7	0.60	0.33	<0.01
			Intervention	115	15.8	179	16.5			
		Total Points	Baseline	163	249	313	262	0.69	0.71	<0.01
			Intervention	111	262	176	258			

Type of Unit	Gender	Event	Phase	MAT		AT		ANCOVA p-values		
				N	Adjusted Mean (reps, min, or points)	N	Adjusted Mean (reps, min, or points)	Group	Phase	Group X Phase
ENG	Men	PU	Baseline	296	56	1023	57	0.77	0.56	0.02
			Intervention	535	56	753	55			
		SU	Baseline	296	66	1023	65	0.41	0.84	<0.01
			Intervention	535	67	753	65			
		2-Mile Run	Baseline	293	14.4	1018	14.2	0.08	0.23	0.40
			Intervention	534	14.4	740	14.0			
		Total Points	Baseline	272	240	1018	242	0.89	0.88	0.28
			Intervention	528	242	736	241			
	Women	PU	Baseline	9	45	21	45	0.59	0.11	0.84
			Intervention	27	39	10	38			
		SU	Baseline	9	67	21	70	0.64	0.27	0.61
			Intervention	27	65	10	64			
		2-Mile Run	Baseline	9	16.9	20	16.2	0.71	0.76	0.06
			Intervention	27	15.7	10	15.7			
		Total Points	Baseline	8	252	20	265	0.92	0.42	0.22
			Intervention	26	278	10	261			

Abbreviations: PU=push-ups; SU=sit-ups; Reps=repetitions; Min=minutes; ANCOVA=Analysis of Covariance; MAT=musculoskeletal action team group; AT=athletic trainer group; BCT=Basic Combat Training; MP=military police training; ENG=engineer training

Table D2. Comparison of Final APFT Scores by Group and Intervention, Controlling for Body Weight

Type of Unit	Gender	Event	Phase	MAT		AT		ANCOVA p-values		
				N	Adjusted Mean (reps, min, or points)	N	Adjusted Mean (reps, min, or points)	Group	Phase	Group X Phase
BCT	Men	PU	Baseline	2606	53	953	53	0.20	0.38	0.46
			Intervention	2263	52	925	53			
		SU	Baseline	2606	61	954	64	0.86	0.96	<0.01
			Intervention	2262	63	925	61			
		2-Mile Run	Baseline	2596	14.9	943	14.8	0.18	0.15	0.07
			Intervention	2258	14.7	923	14.4			
		Total Points	Baseline	2582	224	942	231	0.26	0.93	0.03
			Intervention	2254	227	923	229			
	Women	PU	Baseline	674	31	274	31	0.98	0.66	0.31
			Intervention	892	32	294	31			
		SU	Baseline	673	57	274	61	0.73	0.88	<0.01
			Intervention	891	60	294	59			
		2-Mile Run	Baseline	673	18.0	268	17.6	0.34	0.29	0.12
			Intervention	887	17.6	293	17.5			
		Total Points	Baseline	666	219	268	229	0.44	0.85	0.02
			Intervention	882	225	293	226			

Type of Unit	Gender	Event	Phase	MAT		AT		ANCOVA p-values		
				N	Adjusted Mean (reps, min, or points)	N	Adjusted Mean (reps, min, or points)	Group	Phase	Group X Phase
MP	Men	PU	Baseline	698	57	1265	62	0.45	0.71	<0.01
			Intervention	377	58	551	59			
		SU	Baseline	698	69	1265	72	0.50	0.97	<0.01
			Intervention	377	70	552	70			
		2-Mile Run	Baseline	620	14.1	1265	14.0	0.72	0.35	0.02
			Intervention	377	13.8	551	14.0			
		Total Points	Baseline	608	247	1264	257	0.60	0.87	<0.01
			Intervention	369	254	549	252			
	Women	PU	Baseline	183	36	315	43	0.67	0.99	<0.01
			Intervention	115	41	178	39			
		SU	Baseline	183	67	315	72	0.50	0.82	0.01
			Intervention	115	69	179	69			
		2-Mile Run	Baseline	164	16.8	314	16.7	0.58	0.34	<0.01
			Intervention	115	15.8	179	16.5			
		Total Points	Baseline	162	249	313	262	0.69	0.74	<0.01
			Intervention	111	261	176	258			
ENG	Men	PU	Baseline	296	56	1020	57	0.97	0.47	0.02
			Intervention	533	56	751	55			
		SU	Baseline	296	66	1020	65	0.40	0.62	0.01
			Intervention	533	67	751	65			
		2-Mile Run	Baseline	293	14.5	1015	14.4	0.10	0.25	0.28
			Intervention	532	14.2	740	14.0			
		Total Points	Baseline	272	240	1015	243	0.51	0.80	0.28
			Intervention	526	241	736	241			
	Women	PU	Baseline	9	45	21	45	0.82	0.02	0.87
			Intervention	26	39	10	38			
		SU	Baseline	9	67	21	69	0.61	0.25	0.65
			Intervention	27	65	10	65			
		2-Mile Run	Baseline	9	16.8	20	16.2	0.72	0.86	0.04
			Intervention	27	15.8	10	15.6			
		Total Points	Baseline	8	252	20	264	0.94	0.47	0.17
			Intervention	26	277	10	263			

Abbreviations: PU=push-ups; SU=sit-ups; Reps=repetitions; Min=minutes; ANCOVA=Analysis of Covariance; MAT=musculoskeletal action team group; AT=athletic trainer group; BCT=Basic Combat Training; MP=military police training; ENG=engineer training

Table D3. Comparison of Final APFT Scores by Group and Intervention While Controlling for BMI

Type of Unit	Gender	Event	Phase	MAT		AT		ANCOVA p-values		
				N	Adjusted Mean (reps, min, or points)	N	Adjusted Mean (reps, min, or points)	Group	Phase	Group X Phase
BCT	Men	PU	Baseline	2600	54	952	53	0.25	0.28	0.34
			Intervention	2260	52	923	53			
		SU	Baseline	2600	61	953	64	0.86	0.94	<0.01
			Intervention	2259	63	923	61			
		2-Mile Run	Baseline	2590	14.9	942	14.8	0.19	0.17	0.04
			Intervention	2255	14.7	921	14.4			
		Total Points	Baseline	2576	224	941	231	0.24	0.94	0.06
			Intervention	2251	227	921	230			

Type of Unit	Gender	Event	Phase	MAT		AT		ANCOVA p-values		
				N	Adjusted Mean (reps, min, or points)	N	Adjusted Mean (reps, min, or points)	Group	Phase	Group X Phase
BCT	Women	PU	Baseline	674	31	274	31	0.92	0.37	0.31
			Intervention	892	32	294	31			
		SU	Baseline	673	57	274	61	0.72	0.88	<0.01
			Intervention	891	60	294	59			
		2-Mile Run	Baseline	673	18.0	268	17.6	0.33	0.29	0.10
			Intervention	887	17.6	293	17.5			
		Total Points	Baseline	666	219	268	230	0.43	0.84	0.01
			Intervention	882	225	293	226			
MP	Men	PU	Baseline	698	57	1265	62	0.39	0.75	<0.01
			Intervention	377	58	551	59			
		SU	Baseline	698	70	1265	72	0.50	0.93	<0.01
			Intervention	377	70	552	70			
		2-Mile Run	Baseline	620	14.1	1265	14.0	0.72	0.36	0.01
			Intervention	377	13.8	551	14.0			
		Total Points	Baseline	608	247	1264	256	0.58	0.81	<0.01
			Intervention	373	254	549	253			
	Women	PU	Baseline	183	36	315	43	0.66	0.99	<0.01
			Intervention	115	41	178	39			
		SU	Baseline	183	67	315	72	0.50	0.81	0.02
			Intervention	115	69	179	69			
		2-Mile Run	Baseline	164	16.8	314	16.7	0.58	0.34	<0.01
			Intervention	115	15.8	179	16.5			
		Total Points	Baseline	162	249	313	262	0.68	0.75	<0.01
			Intervention	111	262	176	258			
ENG	Men	PU	Baseline	296	56	1019	57	0.90	0.49	0.02
			Intervention	532	56	751	55			
		SU	Baseline	296	66	1019	65	0.39	0.65	0.01
			Intervention	532	67	751	65			
		2-Mile Run	Baseline	293	14.4	1014	14.2	0.11	0.29	0.26
			Intervention	531	14.4	740	14.0			
		Total Points	Baseline	272	240	1014	243	0.57	0.76	0.26
			Intervention	525	241	736	241			
	Women	PU	Baseline	9	45	21	45	0.45	0.11	0.83
			Intervention	26	39	10	37			
		SU	Baseline	9	67	21	69	0.81	0.28	0.60
			Intervention	27	65	10	64			
		2-Mile Run	Baseline	9	16.9	20	16.2	0.71	0.81	0.04
			Intervention	27	15.7	10	15.6			
		Total Points	Baseline	8	251	20	265	0.91	0.44	0.18
			Intervention	26	278	10	262			

Abbreviations: PU=push-ups; SU=sit-ups; Reps=repetitions; Min=minutes; ANCOVA=Analysis of Covariance; MAT=musculoskeletal action team group; AT=athletic trainer group; BCT=Basic Combat Training; MP=military police training; ENG=engineer training