The Eagle Tactical Athlete Program Reduces Musculoskeletal Injuries in the 101st Airborne Division (Air Assault)

Timothy C. Sell, PhD; John P. Abt, PhD*; Takashi Nagai, PhD*; Jennifer B. Deluzio, MS*; Mita Lovalekar, PhD*; COL Michael D. Wirt, MC USA†; Scott M. Lephart, PhD**

Downloaded from https://academic.oup.com/milmed/article-abstract/181/3/250/4159224 by Chandler Medical Center Library user on 15 August 2019

ABSTRACT The Eagle Tactical Athlete Program (ETAP) was scientifically developed for the U.S. Army's 101st Airborne Division (Air Assault) to counter unintentional musculoskeletal injuries (MSIs). Purpose: To determine if ETAP would reduce unintentional MSIs in a group of 101st Airborne Division (Air Assault) Soldiers. Methods: ETAP-trained noncommissioned led physical training. 1,720 Soldiers were enrolled (N = 1,136 experimental group [EXP], N = 584 control group [CON]) with injuries tracked before and after initiation of ETAP. The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes were analyzed and described the anatomic locations, anatomic sub-locations, onset, and injury types. McNemar tests compared the proportions of injured subjects within each group. Results: There was a significant reduction in the proportion of Soldiers with preventable MSIs in the EXP (pre: 213/1,136 (18.8%), post: 180/1,136 (15.8%), $p = 0.041$) but not in the CON. In addition, there was a significant reduction in stress fractures in the EXP (pre: 14/1,136 (1.2%), post: 5/1,136 (0.4%), $p = 0.022$) but no significant differences in the CON. Conclusion: The current analysis demonstrated that ETAP reduces preventable MSIs in garrison. The capability of ETAP to reduce injuries confirms the vital role of a scientifically designed training program on force readiness and health.

INTRODUCTION

The health, well-being, and quality of life of U.S. military personnel are core missions for multiple federal agencies and throughout all branches of the military. Military personnel face a broad spectrum of injury and medical risks because of their service. Although unintentional musculoskeletal injuries (MSIs) are only one of these risks, it is a significant, persistent, and costly health concern. In 2000, the Armed Forces Epidemiological Board implicated MSIs as having a greater impact on health and readiness than general medical complaints during peacetime and combat.[1] These injuries remain a significant issue in the most recent conflicts[2] and continue to account for a large number of disability reviews,[3,4] lost duty days,[5,6] and disability.[7] Financially, MSIs place a significant burden on medical systems[7] and cost over a billion dollars yearly.[1,3,8] Fortunately, many MSIs are preventable with scientifically driven and population-specific interventions.[4,9–14]

Over the course of 3 years the Eagle Tactical Athlete Program (ETAP) was developed specifically for Soldiers of the 101st Airborne Division (Air Assault) based on examination of injury epidemiology, task and demand analysis, and laboratory testing of Soldiers.[15] The ETAP was developed as a cyclic program that incorporated tapered activity for recovery to reduce the risk of overtraining.[16] Each cycle of training built on the previous cycle with variations in intensity and duration based on the phase of program. The four phases included general adaptation and introduction to the exercises, gradual increase in volume, gradual increase in intensity with less volume, and a final phase that focused on taper prior deployment or cycle reset. Each day of the training week corresponded to different objectives such as speed, agility, balance, strengthening, interval training, power development, and endurance training.[16] In an 8-week clinical trial, the ETAP demonstrated significant improvements across a wide range of capabilities including flexibility, strength, balance, anaerobic power, agility, and Army physical fitness test (APFT) scores. The next evaluation step for ETAP was an assessment of injury reduction as it was implemented across the Division.

The effectiveness of physical training programs to reduce MSIs has been studied in several military populations.[17] Over the past decade, the U.S. Army Physical Fitness School has developed a new physical training program, Army Physical Readiness Training (PRT),[18] to replace the existing training program (FM 21-20)[19] designed to improve physical fitness, prevent injuries, progressively train soldiers, and develop Soldiers' self-confidence and discipline. This training program has been studied across three different environments: Basic Combat Training, Advanced Individual Training, and in an infantry unit. In Basic Combat Training, PRT was able to demonstrate a reduction in overuse injuries but did not demonstrate a reduction in traumatic injuries.[20] Data on specific joint injuries were not provided. The reduction in overuse injuries may have been due primarily to the reduction in running mileage rather than specific training task or exercises.[20] An examination of PRT at Advanced Individual Training demonstrated a reduction in overuse injuries compared to a historical cohort, but only demonstrated a

*Neuromuscular Research Laboratory, University of Pittsburgh, 3830 South Water Street, Pittsburgh, PA 15203.

†U.S. Army Institute of Surgical Research, 3698 Chambers Pass Building 3611, JBSA Fort Sam Houston, TX 78234-6315.

This article was presented in poster format at the American College of Sports Medicine Annual Meeting in Indianapolis, IN May 30, 2013.

Opinions, interpretations, conclusions, and recommendations are those of the authors and are not necessarily endorsed by the U.S. Army.

doi: 10.7205/MILMED-D-14-00674

reduction in traumatic injuries in men.[21] Finally, PRT was examined in an infantry unit and was demonstrated to reduce overuse injuries and overuse injuries of the lower extremity.[17] No data was provided relative to specific joint injuries or if PRT was effective in reducing traumatic injuries.[17] Based on these studies, it appears as though PRT has been effective in some populations but may not be the ideal physical training program for all groups.

Physical training of Soldiers should be specific to their tactical requirements and the physiological, musculoskeletal, and biomechanical demands they encounter during tactical training and mission execution. The fundamental objectives of any training program in the military should be to physically prepare Soldiers for tactical training and deployment while reducing their risk of injury. The ETAP was scientifically and specifically designed for the Army's 101st Airborne Division (Air Assault)[15] and was demonstrated to improve Soldier's strength, flexibility, balance, anaerobic power, agility, and APFT scores.[16] Before this study, the ETAP had not been studied to determine its effectiveness in reducing MSIs. Therefore, the purpose of this study was to examine the capability of ETAP to reduce unintentional MSIs within a group of Soldiers at the Army's 101st Airborne Division (Air Assault). We hypothesized that ETAP would significantly reduce lower extremity injuries, upper extremity injuries, lumbar spine injuries, and both acute and overuse injuries. If these hypotheses were met, it would demonstrate the effectiveness of ETAP to reduce injuries and demonstrate the effectiveness of matching tactical demands to physical training needs/interventions.

METHODS

Subjects

The University of Pittsburgh and Eisenhower Army Medical Center's Institutional Review Boards approved the study. All active duty Soldiers were initially briefed regarding all aspects of the study before discussing voluntary consent. Soldiers who agreed to participate filled out and signed the consent forms as well as the forms for the Health Insurance Portability and Accountability Act. Soldiers were excluded from the study if they had any medical reason that prevented them from participating in the physical training programs. A total of 2,280 Soldiers consented to participate and were block assigned to the experimental group (EXP) and the control group (CON). The EXP included 1,493 Soldiers and the CON included 787 Soldiers.

Intervention

The intervention for the EXP group was the ETAP. The ETAP was specifically designed for the Army's 101st Airborne Division (Air Assault). It has been previously demonstrated to improve Soldier's strength, flexibility, balance, anaerobic power, agility, and APFT scores.[16] The ETAP was designed to improve performance and reduce common MSIs and incorporated four phases that included a general adaptation and introduction to the exercises, gradual increase in volume, gradual increase in intensity with less volume, and a final phase that focused on taper prior deployment or cycle reset. Each day of the week corresponded to a different objectives such as speed, agility, balance, strengthening, interval training, power development, and endurance training. The full details of the ETAP have been published previously.[16] The intervention for the EXP group lasted 5 months. A "train-the-trainer" model of instruction was developed and implemented to provide the appropriate training to deliver the ETAP across the large number of Soldiers participating in the study. The train-the-trainer model has been used previously in the military to transfer essential knowledge to the unit level. The Division offered a 4-day school (ETAP Instructor Certification School [ICS]) for noncommissioned officers (NCOs) to become effective leaders for their morning physical training. At least two NCOs (junior and senior ranked) from each platoon attended the ETAP ICS and became certified, and those ICS certified instructors lead ETAP daily according to the ETAP training guidelines. Soldiers from the CON group participated in the existing physical training program at the Army's 101st Airborne Division (Air Assault), which was based on FM 21-20.[19] The CON group's physical training was led by each platoons' NCOs and lasted the same duration as ETAP. In brief, the CON group's daily physical training session began with a warm-up incorporating a slow jog followed by stretching and calisthenics. Approximately 20 to 45 minutes of cardiorespiratory or strength activities were conducted following the warm-up. Cardiorespiratory activities included distance running, road marching, interval running, and ability group running with target heart rate reserve. Strength activities included muscular endurance, sandbag circuit, and partner resistance exercises. Each training session ended with cooldown activities and stretching.

There are numerous differences between the ETAP and FM 21-20. The ETAP consisted of five main workout sessions with each workout focusing on different components of physical fitness (Day 1: speed/agility/balance, Day 2: muscular strength, Day 3: interval running, Day 4: power, and Day 5: endurance training) whereas the FM 21-20 main workout sessions consists of alternating cardiorespiratory activities and muscular endurance/strength activities. The ETAP progressed nonlinearly every 2 weeks (Phase I: less volume more technique, Phase II: gradual increase in volume, Phase III: gradual increase in intensity with less volume, and Phase IV: tapering) while the FM 21-20 progressed linearly from the preparatory phase to build up the cardiorespiratory and muscular systems with gradual progression and proper technique for 2 weeks to the conditioning phase with gradual progression to the maintenance phase. Throughout each week, the ETAP included additional exercises/stretching for specific joints and different conditions specifically designed for injury prevention.

Downloaded from https://academic.oup.com/milmed/article-abstract/181/3/250/4159224 by Chandler Medical Center Library user on 15 August 2019

Injury Tracking

Injuries were tracked 5 months before and after the initiation of the intervention for both the CON and EXP groups (see Fig. 1). Both groups were in garrison throughout the injury tracking periods and during the intervention. Injuries were tracked utilizing ICD-9-CM coded medical encounter data. Each encounter could have up to eight ICD-9-CM codes. All codes for each encounter were considered if present, and relevant codes were extracted and analyzed further. Relevant codes were identified as follows: a list of individual musculoskeletal ICD-9-CM codes that were relevant to the study and intervention was created by certified athletic trainers, and these codes were classified as preventable or not preventable, and into anatomic locations, acute/overuse; injury types. Preventable injuries were those that, based on the injury classification itself, may be reduced through injury prevention programs (e.g., stress fractures) as well as injuries that potentially are preventable through injury prevention programs; however, injuries cannot be definitively classified as preventable since no information is available regarding the mechanism. Examples include internal derangement of the knee, patellar tendonitis, and sprains and strains of shoulder and upper arm. Examples of injuries that were not classified as preventable include concussions, fractures (e.g., humeral fractures, and nerve entrapment injuries. The statistical analysis was focused on preventable injuries. The following preventable injuries were analyzed: all preventable, upper extremity (shoulder and elbow), lower extremity (hip, knee, lower leg, and ankle/foot), spine (cervical, thoracic, and lumbopelvic), acute/overuse, and injury types (pain/stiffness/effusion, sprains/strains, stress fractures, and tendonitis/tendonopathy/tenosynovitis).

Statistical Analysis

ICD-9-CM codes were analyzed and described according to their anatomic locations, anatomic sub-locations, onset (acute/overuse), and injury types. The proportion of subjects with a specific injury was calculated during a 5-month period before the beginning of ETAP and a 5-month period after the beginning of ETAP, using the formula in Figure 2. Only subjects who were in the Army during the entire 10-month period of the study were included in the analysis. McNemar tests were used to compare the proportions of injured subjects within group in garrison, during a period of 5 months before and after the beginning of ETAP. Data analysis was performed using SPSS 21.0 (IBM Corp, Armonk, New York). Statistical significance was established at $p < 0.05$ a priori.

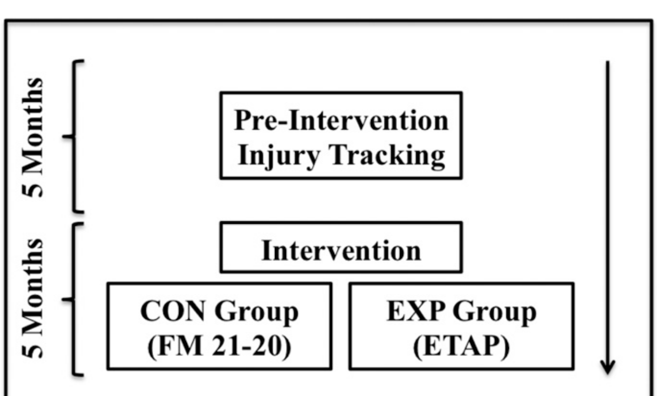

FIGURE 1. Timeline for injury tracking and intervention.

$$\text{Proportion of injured subjects (for each specific injury)} = \frac{\text{number of subjects with} \geq 1 \text{ ICD-9-CM codes associated with specific injury during a five month period}}{\text{number of subjects at risk of injury during the five month period}}$$

FIGURE 2. Calculation of proportion of injured subjects for each injury.

RESULTS

The focus of the analysis was on preventable injuries but all injuries (before classification) are also reported in all of the tables provided. The rest of the results are based on the analysis of preventable injuries as outlined in the methods and statistical analysis sections. The final data set included the 1,136 Soldiers in the EXP and 584 Soldiers in the CON. The distributions of ICD-9-CM codes by anatomic location and anatomic sub-location, in the EXP and CON groups, before and after the beginning of ETAP, are included in Tables I and II. The majority of ICD-9-CM codes were related to the spine and lower extremity anatomic locations (Table I). Furthermore, lumbopelvic, knee, and ankle/foot are 3 most commonly injured anatomic sub-locations (Table II). The distribution of ICD-9-CM codes by injury type is included in Table III, and the distribution by injury onset is included in Table IV. Pain/stiffness/effusion and sprains/strains were the common injury types (Table III). More injuries are classified as predominantly acute than predominantly overuse, although nearly half of all injuries are unspecified (Table IV).

McNemar tests within each group were conducted to compare the proportions of subjects with injuries during a 5-month period before (preINT) and after (postINT) the beginning of ETAP (Table V). The McNemar tests revealed that the proportion of Soldiers with preventable MSIs was significantly decreased in the EXP group (preINT: 213/1,136 (18.8%), postINT: 180/1,136 (15.8%), $p = 0.041$) while there was no significant change in the CON group (preINT: 112/584 (19.2%), postINT: 104/584 (17.8%), $p = 0.530$). Although there were trends toward decreased proportions for the lower extremity injuries and overuse injuries in the EXP group, there were no significant differences between preINT and postINT on anatomical sub-locations and injury onset in the experimental group. There was a significant decrease in the proportion of Soldiers with stress fractures in the

Downloaded from https://academic.oup.com/milmed/article-abstract/181/3/250/4159224 by Chandler Medical Center Library user on 15 August 2019

TABLE I. Anatomic Location Distribution of ICD-9-CM Codes in the Experimental and Control Groups During Two Separate 5-Month Periods (Before and After the Beginning of the Interventions)

	All Injuries								Preventable Injuries							
	EXP Group preINT		EXP Group postINT		CON Group preINT		CON Group postINT		EXP Group preINT		EXP Group postINT		CON Group preINT		CON Group postINT	
Anatomic Location	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Head and Face	30	1.6	40	2.7	21	2.3	26	2.8	0	0.0	0	0.0	0	0.0	0	0.0
Lower Extremity	823	44.0	627	41.7	427	45.9	483	51.9	229	45.2	160	38.6	115	43.6	112	42.1
Spine	530	28.3	481	32.0	206	22.2	195	21.0	255	50.3	233	56.3	135	51.1	141	53.0
Torso	41	2.2	16	1.1	20	2.2	25	2.7	0	0.0	0	0.0	0	0.0	0	0.0
Upper Extremity	253	13.5	210	14.0	169	18.2	144	15.5	11	2.2	14	3.4	7	2.7	6	2.3
Unspecified	193	10.3	129	8.6	87	9.4	57	6.1	12	2.4	7	1.7	7	2.7	7	2.6
Total	1,870		1,503		930		930		507		414		264		266	

EXP group (preINT: 14/1,136 (1.2%), postINT: 5/1,136 (0.4%), $p = 0.022$). For the CON group, there were no significant differences between preINT and postINT.

DISCUSSION

The primary purpose of this study was to examine the capability of ETAP to reduce unintentional MSIs in a group of Soldiers at the Army's 101st Airborne Division (Air Assault). The primary finding from this study is the ETAP's capability to reduce preventable MSIs. The statistical analysis revealed a significant reduction for all injuries (without regard for injury type, location, or onset) and for stress fractures. In addition a nonsignificant reduction was observed for overuse injuries and injuries to lower extremity. These results met our hypothesis that the ETAP would reduce unintentional MSIs, although some of the injury specific hypotheses were not met. These results combined with the improvements observed in strength, flexibility, balance, anaerobic power, agility, and APFT scores[16] provide evidence that a scientifically designed training program that is population specific to occupational demands and injury profiles will be effective in improving force readiness and health.

Comparisons between this study and previous studies are somewhat limited as there are only a few studies that have examined the injury reduction capabilities of physical training programs in the Army. The revised physical training program of record for the Army, the (PRT) program, has been assessed for injury prevention capability on three occasions. The PRT was examined in Basic Combat Training over a 9-week period and was demonstrated to reduce overuse injuries similar to ETAP but did reduce traumatic injuries.[20] The authors indicated that the reduction of overuse injury was likely because of a reduction in formation running mileage and potentially through the variety of exercises employed. The examination of PRT during Advanced Individualized Training over 36 weeks compared to a historical control revealed significant reduction in overuse (both genders) and traumatic injuries (males only) but did not demonstrate a reduction across all categorized injuries.[21] The PRT program has also been examined in an infantry unit preparing for deployment and was demonstrated to reduce both overuse and acute injuries.[17] The studies examining PRT have demonstrated similar results to ETAP as both have demonstrated a reduction in overuse injuries.

The principal reason for the reduction of injuries is attributable to the scientific design of the ETAP,[16] which incorporated occupational task and demand analyses, injury epidemiology, and assessments of the current physiological, musculoskeletal, and biomechanical capabilities of the target population.[15] It was a cyclical program that included four phases to gradually increase volume, intensity, and running distance while allowing for appropriate rest and accommodation/acclimation to the activities. Phase I focused on introduction and general adaptation to ETAP exercises; Phase II focused on a gradual increase in volume; Phase III focused increasing intensity with no change in volume; and Phase IV focused on taper before deployment or training cycle reset. Each week included five different workout sessions to address speed, agility, and balance; muscular strength; interval training for anaerobic power development; power development; and aerobic endurance training. Each day began with a dynamic warm-up and a cooldown with static stretch. Specific exercises were also included throughout the week to address risk factors for injury based on laboratory testing of over 400 Soldiers.[15]

Success of the ETAP can also be linked to the implementation and integration of an ICS. Implementation of ETAP across the entire division including those participating in this study required hundreds of NCOs to lead physical training, which required the appropriate knowledge and training to effectively and with the appropriate quality deliver the ETAP. Each of the NCOs who led training participated and graduated from a 4-day ICS that included the ETAP physical training workout cards to assist their morning physical training and videos with course presentations and related

Downloaded from https://academic.oup.com/milmed/article-abstract/181/3/250/4159224 by Chandler Medical Center Library user on 15 August 2019

TABLE II. Anatomic Sub-Location Distribution of ICD-9-CM Codes in the Experimental and Control Groups During Two Separate 5-Month Periods (Before and After the Beginning of the Interventions)

		All Injuries								Preventable Injuries							
		EXP Group preINT		EXP Group postINT		CON Group preINT		CON Group postINT		EXP Group preINT		EXP Group postINT		CON Group preINT		CON Group postINT	
Anatomic Location	Anatomic Sub-Location	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Head and Face	Concussion	1	0.1	5	0.3	3	0.3	2	0.2	0	0.0	0	0.0	0	0.0	0	0.0
	Eye	4	0.2	4	0.3	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
	Unspecified	25	1.3	31	2.1	18	1.9	23	2.5	0	0.0	0	0.0	0	0.0	0	0.0
Lower Extremity	Ankle/Foot	279	14.9	254	16.9	152	16.3	82	8.8	83	16.4	66	15.9	49	18.6	23	8.6
	Hip	19	1.0	9	0.6	8	0.9	3	0.3	19	3.7	9	2.2	8	3.0	2	0.8
	Knee	144	7.7	98	6.5	69	7.4	113	12.2	111	21.9	71	17.1	50	18.9	85	32.0
	Lower Leg	308	16.5	227	15.1	182	19.6	270	29.0	11	2.2	10	2.4	6	2.3	2	0.8
	Thigh	61	3.3	30	2.0	10	1.1	13	1.4	1	0.2	3	0.7	0	0.0	0	0.0
	Unspecified	12	0.6	9	0.6	6	0.6	2	0.2	4	0.8	1	0.2	2	0.8	0	0.0
Spine	Cervical	59	3.2	68	4.5	17	1.8	7	0.8	34	6.7	27	6.5	7	2.7	7	2.6
	Lumbopelvic	331	17.7	323	21.5	155	16.7	164	17.6	216	42.6	202	48.8	125	47.3	133	50.0
	Thoracic	29	1.6	32	2.1	11	1.2	6	0.6	3	0.6	2	0.5	3	1.1	1	0.4
	Unspecified	111	5.9	58	3.9	23	2.5	18	1.9	2	0.4	2	0.5	0	0.0	0	0.0
Torso	Chest	20	1.1	6	0.4	6	0.6	11	1.2	0	0.0	0	0.0	0	0.0	0	0.0
	Abdomen	19	1.0	7	0.5	14	1.5	13	1.4	0	0.0	0	0.0	0	0.0	0	0.0
	Unspecified	2	0.1	3	0.2	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Upper Extremity	Elbow	3	0.2	25	1.7	5	0.5	2	0.2	2	0.4	10	2.4	0	0.0	1	0.4
	Forearm	30	1.6	19	1.3	8	0.9	12	1.3	0	0.0	0	0.0	0	0.0	0	0.0
	Hand and Fingers	59	3.2	36	2.4	39	4.2	26	2.8	0	0.0	0	0.0	0	0.0	0	0.0
	Shoulder	123	6.6	119	7.9	99	10.6	81	8.7	9	1.8	4	1.0	7	2.7	4	1.5
	Upper Arm	5	0.3	3	0.2	12	1.3	11	1.2	0	0.0	0	0.0	0	0.0	1	0.4
	Wrist	8	0.4	4	0.3	4	0.4	8	0.9	0	0.0	0	0.0	0	0.0	0	0.0
	Unspecified	25	1.3	4	0.3	2	0.2	4	0.4	0	0.0	0	0.0	0	0.0	0	0.0
Unspecified		193	10.3	129	8.6	87	9.4	57	6.1	12	2.4	7	1.7	7	2.7	7	2.6
Total		1,870		1,503		930		930		507		414		264		266	

Downloaded from https://academic.oup.com/milmed/article-abstract/181/3/250/4159224 by Chandler Medical Center Library user on 15 August 2019

TABLE III. Type of Injury Distribution of ICD-9-CM Codes in the Experimental and Control groups During Two Separate 5-Month Periods (Pre- and Postintervention)

	All Injuries								Preventable Injuries							
	EXP Group preINT		EXP Group postINT		CON Group preINT		CON Group postINT		EXP Group preINT		EXP Group postINT		CON Group preINT		CON Group postINT	
Type of Injury	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Concussion	1	0.1	5	0.3	3	0.3	2	0.2	0	0.0	0	0.0	0	0.0	0	0.0
Dislocation	16	0.9	17	1.1	16	1.7	13	1.4	0	0.0	0	0.0	0	0.0	0	0.0
Fracture	90	4.8	45	3.0	33	3.5	32	3.4	0	0.0	0	0.0	0	0.0	0	0.0
Pain/Stiffness/ Effusion	799	42.7	595	39.6	441	47.4	508	54.6	191	37.7	176	42.5	112	42.4	117	44.0
Sprains/Strains	242	12.9	193	12.8	124	13.3	120	12.9	170	33.5	140	33.8	97	36.7	95	35.7
Stress Fracture	28	1.5	10	0.7	4	0.4	3	0.3	28	5.5	10	2.4	4	1.5	3	1.1
Tendonitis/ Tendonopathy/ Tenosynovitis	54	2.9	32	2.1	24	2.6	17	1.8	53	10.5	31	7.5	23	8.7	15	5.6
Unspecified	640	34.2	606	40.3	285	30.6	235	25.3	65	12.8	57	13.8	28	10.6	36	13.5
Total	1,870		1,503		930		930		507		414		264		266	

TABLE IV. Onset: Predominantly Acute or Predominantly Overuse (ICD-9-CM Codes that are Predominantly Acute, but Could be Sometimes Overuse, and Vice Versa); or Unspecified (Cannot be Classified), in the Experimental and Control Groups During Two Separate 5-Month Periods (Before and After the Beginning of the Interventions)

	All Injuries								Preventable Injuries							
	EXP Group preINT		EXP Group postINT		CON Group preINT		CON Group postINT		EXP Group preINT		EXP Group postINT		CON Group preINT		CON Group postINT	
Injury Onset	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Acute	425	22.7	329	21.9	220	23.7	199	21.4	170	33.5	140	33.8	97	36.7	95	35.7
Overuse	197	10.5	184	12.2	99	10.6	78	8.4	117	23.1	75	18.1	47	17.8	42	15.8
Unspecified	1,248	66.7	990	65.9	611	65.7	653	70.2	220	43.4	199	48.1	120	45.5	129	48.5
Total	1,870		1,503		930		930		507		414		264		266	

information for them to share with others as well as to refresh their learned knowledge. The transfer of knowledge and training skills of these NCOs were essential to the success of the program. A validation study was performed to confirm that the ICS was appropriately designed with an effective transfer of knowledge to the NCOs.[22] Eight NCOs were enrolled in ICS and subsequently returned to their companies to deliver the ETAP. The Soldiers trained by the NCOs who were enrolled in the ICS were tested in the laboratory across multiple measures of musculoskeletal, physiological, and performance measures before and after the 4-month ETAP training period. Post-testing revealed significant increases in APFT scores, anaerobic capacity, strength, flexibility, balance, and landing biomechanics demonstrating the effectiveness of the NCOs to deliver the ETAP as designed.

A successful injury prevention program has the added benefit of reducing the significant cost associated with MSIs. Teyhen et al[23] referenced a cost analysis that indicated that MSIs during fiscal year 2007 cost $548 million. Teyhen et al[24] reported on the costs associated with 668 lower extremity injuries for which military personnel sought medical care. These injuries accounted for over 2,100 medical visits and cost $436,965 or approximately $654 per injury. The ETAP, based on these numbers would have a significant impact on the cost of care of MSIs in the Division. The EXP group who participated in the ETAP experienced a reduction of 33 injuries during the 5-month period of the intervention for a group of 1,136 soldiers. This would account for a reduction of $21,582 ($654/injury) in medical care costs using data from the NATO report referenced above.[24] Potentially this could account for a reduction of $379,974 over a 5-month period in medical care costs if extrapolated across the approximate 20,000 Soldiers in the 101st Airborne Division (Air Assault).

There are several potential limitations based on this study. Injuries and description of injuries are based on ICD-9 codes, which may not be comprehensive and may have errors. Groups were assigned based on block randomization because of deployment schedules and groups were not blinded. The primary analysis performed in this study was an examination of preventable injuries, which was based on an operation definition created by the investigators to focus on injuries that may be preventable through physical training. Other injuries that were not classified as preventable may or may not be affected by physical training.

Downloaded from https://academic.oup.com/milmed/article-abstract/181/3/250/4159224 by Chandler Medical Center Library user on 15 August 2019

TABLE V. Results of McNemar Tests

	All Injuries						Preventable Injuries					
	EXP Group (n = 1,136)			CON Group (n = 584)			EXP Group (n = 1,136)			CON Group (n = 584)		
	preINTCount (Percent)	postINTCount (Percent)	p-value	preINTCount (Percent)	postINTCount (Percent)	p-value	preINTCount (Percent)	postINTCount (Percent)	p-value	preINTCount (Percent)	postINTCount (Percent)	p-value
All Injuries	441 (38.8)	402 (35.4)	0.045	223 (38.2)	218 (37.3)	0.773	213 (18.8)	180 (15.8)	0.041	112 (19.2)	104 (17.8)	0.530
Upper Extremity Injuries	107 (9.4)	89 (7.8)	0.159	50 (8.6)	46 (7.9)	0.699	6 (0.5)	7 (0.6)	1.000	6 (1.0)	4 (0.7)	0.754
Lower Extremity Injuries	243 (21.4)	214 (18.8)	0.079	135 (23.1)	111 (19.0)	0.047	124 (10.9)	100 (8.8)	0.076	64 (11.0)	54 (9.2)	0.326
Spine Injuries	111 (9.8)	110 (9.7)	1.000	59 (10.1)	59 (10.1)	1.000	89 (7.8)	83 (7.3)	0.637	49 (8.4)	48 (8.2)	1.000
Shoulder Injuries	48 (4.2)	41 (3.6)	0.443	24 (4.1)	27 (4.6)	0.736	5 (0.4)	4 (0.4)	1.000	6 (1.0)	2 (0.3)	0.289
Elbow Injuries	2 (0.2)	8 (0.7)	0.109	1 (0.2)	2 (0.3)	1.000	1 (0.1)	3 (0.3)	0.625	0 (0.0)	1 (0.2)	N/A
Hip Injuries	14 (1.2)	9 (0.8)	0.359	5 (0.9)	3 (0.5)	0.727	14 (1.2)	9 (0.8)	0.359	5 (0.9)	2 (0.3)	0.453
Knee Injuries	68 (6.0)	53 (4.7)	0.159	36 (6.2)	42 (7.2)	0.497	60 (5.3)	46 (4.0)	0.198	33 (5.7)	35 (6.0)	0.888
Lower Leg Injuries	103 (9.1)	93 (8.2)	0.407	62 (10.6)	57 (9.8)	0.609	9 (0.8)	4 (0.4)	0.180	4 (0.7)	1 (0.2)	0.375
Ankle/Foot Injuries	95 (8.4)	94 (8.3)	1.000	59 (10.1)	34 (5.8)	0.003	52 (4.6)	43 (3.8)	0.380	24 (4.1)	17 (2.9)	0.265
Cervical Spine Injuries	18 (1.6)	16 (1.4)	0.845	10 (1.7)	5 (0.9)	0.302	16 (1.4)	13 (1.1)	0.690	6 (1.0)	5 (0.9)	1.000
Thoracic Spine Injuries	16 (1.4)	13 (1.1)	0.664	6 (1.0)	6 (1.0)	1.000	3 (0.3)	2 (0.2)	1.000	2 (0.3)	1 (0.2)	1.000
Lumbopelvic Spine Injuries	83 (7.3)	85 (7.5)	0.922	45 (7.7)	51 (8.7)	0.504	75 (6.6)	70 (6.2)	0.682	41 (7.0)	43 (7.4)	0.888
Acute Injuries	203 (17.9)	178 (15.7)	0.149	117 (20.0)	95 (16.3)	0.086	111 (9.8)	92 (8.1)	0.168	59 (10.1)	49 (8.4)	0.320
Overuse Injuries	92 (8.1)	80 (7.0)	0.315	52 (8.9)	45 (7.7)	0.477	60 (5.3)	45 (4.0)	0.086	29 (5.0)	23 (3.9)	0.461
Pain/Stiffness/Effusion	247 (21.7)	217 (19.1)	0.064	126 (21.6)	121 (20.7)	0.727	64 (5.6)	57 (5.0)	0.483	35 (6.0)	35 (6.0)	1.000
Sprains/Strains	141 (12.4)	119 (10.5)	0.145	77 (13.2)	67 (11.5)	0.395	111 (9.8)	92 (8.1)	0.168	59 (10.1)	49 (8.4)	0.320
Stress Fracture	14 (1.2)	5 (0.4)	0.022	2 (0.3)	1 (0.2)	1.000	14 (1.2)	5 (0.4)	0.022	2 (0.3)	1 (0.2)	1.000
Tendonitis/Tendonopathy/ Tenosynovitis	27 (2.4)	18 (1.6)	0.136	14 (2.4)	13 (2.2)	1.000	25 (2.2)	17 (1.5)	0.185	13 (2.2)	12 (2.1)	1.000

Downloaded from https://academic.oup.com/milmed/article-abstract/181/3/250/4159224 by Chandler Medical Center Library user on 15 August 2019

CONCLUSIONS

The ETAP was scientifically designed to optimize performance and reduce injuries with specificity to the U.S. Army's 101st Airborne Division (Air Assault). Multiple studies were performed to determine the optimal design factors for physical training relative to the occupational demands of the Division and the injury epidemiology profile. A validation study was performed before this study, which demonstrated the ability of the ETAP to improve physical performance and modify musculoskeletal and biomechanical characteristics necessary for injury reduction. This study demonstrated the effectiveness of the ETAP to reduce unintentional MSIs across a large cohort of Soldiers. Combined, the two studies demonstrate and confirm the vital role of a scientifically designed training program on force readiness and health.

ACKNOWLEDGMENTS

We would like to thank the Soldiers of the U.S Army's 101st Airborne Division (Air Assault).Their time and effort was essential to the success of the ETAP. Supported by the U.S. Army Medical Research and Materiel Command under Award No. W81XWH-06-2-0070/W81XWH-09-2-0095/W81XWH-11-2-0097.

REFERENCES

1. Jones BH, Hansen BC: An armed forces epidemiological board evaluation of injuries in the military. Am J Prev Med 2000; 18(Suppl 3): 14–25.
2. Jones BH, Canham-Chervak M, Canada S, Mitchener TA, Moore S: Medical surveillance of injuries in the U.S. Military descriptive epidemiology and recommendations for improvement. Am J Prev Med 2010; 38(Suppl 1): S42–S60.
3. Songer TJ, LaPorte RE: Disabilities due to injury in the military. Am J Prev Med 2000; 18(Suppl 3): 33–40.
4. Litow FK, Krahl PL: Public health potential of a disability tracking system: analysis of U.S. Navy and Marine Corps Physical Evaluation Boards 2005–2006. Mil Med 2007; 12: 1270–4.
5. Lauder TD, Baker SP, Smith GS, Lincoln AE: Sports and physical training injury hospitalizations in the army. Am J Prev Med 2000; 18(Suppl 3): 118–28.
6. Popovich RM, Gardner JW, Potter R, Knapik JJ, Jones BH: Effect of rest from running on overuse injuries in army basic training. Am J Prev Med 2000; 18(Suppl 3): 147–55.
7. Kelley PW: Military Preventive Medicine: Mobilization and Deployment. Washington, DC, United States Department of the Army, Borden Institute, Walter Reed Army Medical Center, 2003.
8. Garamone J: Reducing Sports Injuries. Available at http://www.defense.gov/news/newsarticle.aspx?id=45753; accessed April 20, 2015.
9. Kaufman KR, Brodine S, Shaffer R: Military training-related injuries: surveillance, research, and prevention. Am J Prev Med 2000; 18(Suppl 3): 54–63.
10. Knapik J, Ang P, Reynolds K, Jones B: Physical fitness, age, and injury incidence in infantry soldiers. J Occup Med 1993; 35(6): 598–603.
11. Sanders JW, Putnam SD, Frankart C, et al: Impact of illness and non-combat injury during Operations Iraqi Freedom and Enduring Freedom (Afghanistan). Am J Trop Med Hyg 2005; 73(4): 713–9.
12. Rivara FP: An overview of injury research. In: Injury Control: A Guide to Research and Program Evaluation, pp 1–14. Edited by Rivara FP, Cummings P, Koepsell TD, Grossman DC, Maier RV. Cambridge, NY, Cambridge University Press, 2001.
13. Mercy JA, Rosenberg ML, Powell KE, Broome CV, Roper WL: Public health policy for preventing violence. Health Aff 1993; 12(4): 7–29.
14. Robertson LS: Injury Epidemiology. New York, Oxford University Press, 1992.
15. Sell TC, Abt JP, Crawford K, et al: Warrior model for human performance and injury prevention: Eagle Tactical Athlete Program (ETAP)—Part I. J Spec Oper Med 2010; 10(4): 2–21.
16. Abt JP, Sell TC, Crawford K, et al. Warrior model for human performance and injury prevention: Eagle Tactical Athlete Program (ETAP)—Part II. J Spec Oper Med 2010; 10(4): 22–33.
17. Knapik JJ, Rieger W, Palkoska F, Van Camp S, Darakjy S: United States Army physical readiness training: rationale and evaluation of the physical training doctrine. J Strength Cond Res 2009; 23(4): 1353–62.
18. U.S. Army Physical Readiness Training Information. ARMYPRT.com. Available at http://www.armyprt.com/index.shtml; accessed November 25, 2014.
19. Department of the Army Headquarters. Physical Fitness Training (FM 21-20). Available at http://rotc.uci.edu/roo/FM%2021-20.pdf; accessed November 25, 2014.
20. Knapik JJ, Hauret KG, Arnold S, et al: Injury and fitness outcomes during implementation of physical readiness training. Int J Sports Med 2003; 24(5): 372–81.
21. Knapik JJ, Bullock SH, Canada S, et al: Influence of an injury reduction program on injury and fitness outcomes among soldiers. Inj Prev 2004; 10(1): 37–42.
22. Abt JP, Sell TC, Nagai T, Deluzio JB, Wirt MD, Lephart SM: Validation of unit level instructed Eagle Tactical Athlete Program to modify human performance characteristics. Med Sci Sport Exer 2013; 45(Suppl 1 5S): 610.
23. Teyhen D, Bergeron MF, Deuster P, et al: Consortium for health and military performance and American College of Sports Medicine Summit: utility of functional movement assessment in identifying musculoskeletal injury risk. Curr Sports Med Rep 2014; 13(1): 52–63.
24. Teyhen DS, Nelson LA, Koppenhaver SL, et al: Impact of foot type on cost of lower extremity injury, 2013. Available at www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA602307; accessed November 25, 2014.

Downloaded from https://academic.oup.com/milmed/article-abstract/181/3/250/4159224 by Chandler Medical Center Library user on 15 August 2019