REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
31 March 2014	Technical Report	

4. TITLE AND SUBTITLE

Quantification of Physical Activity During Basic Combat Training and Associated Injuries

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

T14-4

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

U.S. Army Medical Research and Materiel Command
Fort Detrick
Frederick, MD 21702-5012

10. SPONSOR/MONITOR'S ACRONYM(S)

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

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for Public Release; unlimited distribution

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Musculoskeletal injuries are common among recruits in Basic Combat Training (BCT) and have been systematically investigated for over 35 years. Studies have identified factors that put recruits at risk of injury and these have included female gender, oder age, high and low body mass index (BMI), low initial physical fitness, prior physical inactivity, cigarette smoking, prior injuries and menstrual irregularities, the summer season and higher level of ambulatory activity. In BCT, interventions that have been demonstrated to reduce or moderate the consequences of injuries have included modifications in physical training, preconditioning of recruits, moving medical assets closer to recruits, the use of sok systems and antiperspirants to reduce foot blisters and the use of mouth guards for the reduction of orofacial injuries. These and other efforts have led to a decline in BCT injuries over time, but injury incidence is still relatively high. The most recent study conducted in 2010-2011 at Ft. Leonard Wood, MO, showed that 25% of men and 49% of women experienced one or more injuries during training.

15. SUBJECT TERMS

Injury, Basic Combat Training (BCT), probability

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dr. Jan Redmond
UNCL	UNCL	UNCL	UL	107	*19b.* TELEPHONE NUMBER *(Include area code)* 508-233-4800

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USARIEM TECHNICAL REPORT T14-4

QUANTIFICATION OF PHYSICAL ACTIVITY DURING BASIC COMBAT TRAINING AND ASSOCIATION WITH INJURIES

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Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to Army Regulation 70-25 and USAMRMC Regulation 70-25 on the use of volunteers in research. For protection of human subjects, the investigator(s) adhered to policies of applicable federal law CFR 46.

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DEFINITIONS

United States Army Research Institute of Environmental Medicine	USARIEM
Basic Combat Training	BCT
Body Mass Index	BMI
Training, Overuse Injury and Performance Model	TOP Model
Army Physical Fitness Test	APFT
Military Occupational Specialty	MOS
Physical Activity	PA
Physical Readiness Training	PRT
Risk Ratio	RR
Confidence Interval	CI
US Army Recruiting Command	USAREC
US Military Entrance Processing Command	USMEPCOM
Training and Doctrine Command	TRADOC
Physical Activity Count	PAC
System for Observing Fitness Instruction Time	SOFIT
Behaviors of Eating and Physical Activity for Children's Health	BEACHES
Global Positioning System	GPS
Massachusetts Institute of Technology	MIT
Resident Individual Tracking Management System	RITMS
Defense Medical Surveillance System	DMSS
Armed Forces Health Surveillance Center	AFHSC
Military Treatment Facilities	MTFs
International Classification of Diseases Revision 9, Clinical Modification	ICD-9-CM
Installation Injury Index	III
Modified Installation Injury Index	MIII
Training Related Injury Index	TRII
Overuse Injury Index	OII
Comprehensive Injury Index	CII
Limits of Agreement	LoA

ACKNOWLEDGEMENTS

The authors would like to thank the following individuals for their assistance in preparing this technical report: Nathan Hendrickson, Peter Frykman, Dr Barry Spiering, Shane Sauer, Leila Walker, SSG Carl Larcom, SGT Eric Jacobson and SGT Reeshemah Ward of the United States Army Research Institute of Environmental Medicine (USARIEM) for assisting in data collection; Bria Graham, Shamola Greene and Andrea Harris of the US Army Public Health Command for assisting in data collection and injury data analysis; Majid Hosseini of L-3/Jaycor for assisting with data analysis; Brian Telfer from the Massachusetts Institute of Technology Lincoln Labs for assisting in analysis of the GPS data; the personnel assigned to Ft Jackson and Ft Sill for facilitating and allowing us to conduct the study.

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The opinions or assertions contained herein are the private views of the author(s) and are not to be construed as official or as reflecting the views of the Army or the Department of Defense.

The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219. Protocol # 9300.

BACKGROUND

Musculoskeletal injuries are common among recruits in Basic Combat Training (BCT) and have been systematically investigated for over 35 years [1]. Studies have identified factors that put recruits at risk of injury and these have included female gender, older age, high and low body mass index (BMI), low initial physical fitness, prior physical inactivity, cigarette smoking, prior injuries and menstrual irregularities, the summer season and higher level of ambulatory activity [1,2]. In BCT, interventions that have been demonstrated to reduce or moderate the consequences of injuries have included modifications in physical training [3], preconditioning of recruits [4] moving medical assets closer to recruits [5], the use of sock systems [6] and antiperspirants [7] to reduce foot blisters and the use of mouth guards for the reduction of orofacial injuries [8]. These and other efforts have led to a decline in BCT injuries over time as shown in Figure 1 [9], but injury incidence is still relatively high. The most recent study conducted in 2010-2011 at Fort Leonard, Missouri, showed that 25% of men and 49% of women experienced one or more injuries during training [10].

In a continuing effort to reduce injuries in BCT, the Training, Overuse Injury and Performance (TOP) model, was developed by USARIEM and Jaycor/L-3 Communications. The TOP model is a software tool designed to predict which recruits will be injured during BCT as well as which recruits will likely fail the Army Physical Fitness Test (APFT). An accurate prediction of negative outcomes for recruits entering BCT may allow for identification of at-risk recruits and suggest intervention programs, or a more appropriate military occupational specialty (MOS) that may result in the graduation of more combat-ready recruits. A primary reason for the initiation of this study was to provide descriptive data to be used to improve the predictive capacity of the TOP model. A necessary variable to complete this injury prediction equation is the amount (quantity and quality) of physical activity that recruits are exposed to during BCT.

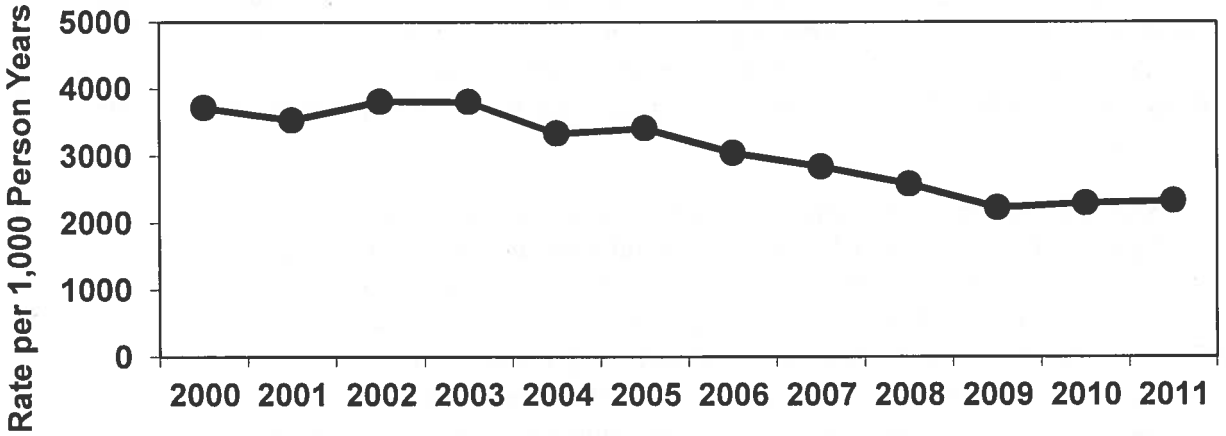


Figure 1. United States Army Recruit Injury Visit Rate 2000-2011.
Prepared by: U.S. Army Public Health Command, Injury Prevention Program Data source: Armed Forces Health Surveillance Center, Defense Medical Surveillance System, 2012

EXECUTIVE SUMMARY

BCT graduation requirements are identical across training sites. Nonetheless, there is little information regarding the actual volume of physical activity (PA) recruits perform at each of the four U.S. Army BCT sites as well as how this activity might influence injury rates. This study was undertaken to characterize the volume of physical activity during BCT and to examine how this may impact injury rates.

A detailed dataset was obtained describing the quantity of PA recruits performed during the middle 8 weeks of a 10-week BCT course at two Army BCT site locations. Recruit PA levels were measured via electronic monitoring devices (accelerometers), direct observation (PAtracker), and self-report surveys (PA log). Results from PA monitoring were summarized by location. Associations between PA, injuries, physical fitness, and other factors were examined. In addition, other known injury risk factors prior to BCT (gender, age, physical fitness, tobacco use, previous injury) were assessed via survey. 414 men and 149 women volunteered to participate at Ft Jackson, SC from June-Aug 2010. 476 men and 167 women volunteered to participate at Ft Sill, OK from July-October 2011.

According to accelerometry, recruits at Ft Jackson spent a larger percentage of their time engaged in light intensity activities (23.0±10.4% vs. 15.8±2.0%, $p<0.001$) and a smaller percentage of their time in sedentary activities (58.9±10.6% vs. 65.9±4.9%, $p<0.001$) when compared to recruits at Ft Sill. Additionally, recruits at both training sites spent most of their time (60-70%) in sedentary activities and less time (<10%) in vigorous activities. Over the course of BCT, recruits at Ft Jackson spent an average of 46.1±4.9 $min \cdot d^{-1}$ while recruits at Ft Sill spent an average of 44.4±3.8 $min \cdot d^{-1}$ participating in moderate to vigorous intensity PA between 0500 and 0700 hours ($p=0.443$) during Physical Readiness Training (PRT).

When the accelerometer data were truncated so that the number of days (44 days) and hours of training (12 hours) were equated, there was little difference in the number of total accelerometer counts between the two training sites (342,451±99,430 vs. 358,413±123,666 counts/day, p=0.12). Similarly, when different levels of physical activity were examined within locations, there was little consistent relationship between the level of physical activity within locations and injuries.

According to observation methods recruits at Ft Jackson spent a larger percentage of time sitting (38.6±12.9% vs. 30.9±11.8%, p<0.001) and a smaller percentage of time kneeling (1.2±1.8% vs. 1.9±2.6%, p<0.001) and standing (57.0±12.6% vs. 64.0±12.2%, p<0.001) compared with recruits at Ft Sill. Recruits at Ft Jackson spent a larger percentage of time sedentary (54.5±18.1% vs. 48.2±22.6%, p=0.001) and a smaller percentage of time in light activities (36.5±15.5% vs. 44.1±21.8%, p<0.001) when compared to recruits at Ft Sill. As was the case with the accelerometer, recruits at both training sites spent a large percentage of time (about 50%) in sedentary activities and a small percentage of time (about 1%) in vigorous activities. Little difference was observed between the two training sites in terms of percentage of time recruits spent in calisthenics (3.9±3.6% vs. 3.8±3.0%, p=0.700). Recruits at Ft Jackson spent a larger percentage of time carrying 0-10lbs (84.0±19.0% vs. 79.6±19.7%, p=0.011) and a smaller percentage of time carrying 25-50lbs (3.5±7.5% vs. 9.7±13.6%, p<0.001) and 50-75lbs (0.2±1.2% vs. 1.0±3.2%, p<0.001). Recruits at both training sites spent a large percentage of

time (about 80%) carrying 0-10lbs and a very small percentage of time (≤1%) carrying over 50lbs.

According to the self-report log recruits at Ft Jackson reported spending a larger percentage of time sitting (48.7±13.6% vs. 42.2±5.7%, $p<0.001$) and walking (21.8±8.7% vs. 18.5±2.7%, $p<0.001$), and a smaller percentage of time standing (24.0±7.3% vs. 33.5±4.8%, $p<0.001$) and running (5.4±3.2% vs. 5.9±1.5%, $p=0.034$) than recruits at Ft Sill. Recruits at Ft Jackson also reported spending a larger percentage of time doing chores (4.5±2.8% vs. 3.8±1.3%, $p=0.002$), performing calisthenics (10.0±7.7% vs. 8.6±2.5%, $p=0.006$) and carrying loads (16.9±12.8% vs. 7.9±2.4%, $p<0.001$) than recruits at Ft Sill. Over the course of BCT, recruits at Ft Jackson reported spending less time sleeping each night than recruits at Ft Sill (364.7±41.1 min•night-1 vs. 376.6±17.5 min·night-1, $p<0.001$).

When comparing the three PA quantification methods (accelerometer, PAtracker and PA log) utilized in this study, weak but positive Pearson correlations ($r = .033$ to $.268$) were observed between the PAtracker and daily PA log for body position and type of PA.

Among men, 32% experienced one or more injuries at Ft Jackson and 21% at Ft Sill risk ratio (RR)=1.51, 95% confidence interval (95%CI)=1.21-1.88); among the women, 55% experienced one or more injuries at Ft Jackson and 36% at Ft Sill (risk ratio(RR)=1.51, 95% confidence interval (95%CI)=1.18-1.94). While there were differences in injury rates between the two BCT sites this result cannot be attributed to a practical difference in PA or PRT demands, which were similar at both sites.

Despite statistical significance, regardless of the technique used to measure PA the practical differences between the two BCT sites were small. Recruits at both training sites spent a very large percentage of time sedentary (about 80%) and a very small percentage of time in vigorous intensity activities (about 5%). Recruits from both training sites spent a very large percentage of time (roughly 80%) unloaded or carrying very light loads (0-10lbs) and a very small percentage of time carrying loads weighing over 50lbs (1-2%). Moderate to vigorous activity tended to increase during the first 4 weeks of BCT at Ft Jackson. Although we cannot determine from these data if the specific drills of PRT were followed, it appears that the amount of time spent in these general activities was similar at the two sites. This suggests that US Army BCT recruits spent similar amounts of time in each PA intensity, activity type, body position, and carrying various external loads at the two locations tested. Whether or not this applies to all BCT sites will need to be determined with future studies. In this study, the ActiGraph accelerometer provided the best measure of a recruit's PA intensity while the PAtracker and daily PA log were best at capturing body position and type of PA in the BCT environment.

This is the first study to quantify the amount, type, and intensity of PA demands during BCT. Physical activity and PRT during BCT were found to be consistent between sites. It appears that the amount of PA and PRT conducted during BCT is not related to the differences in injury incidence between the two sites. Findings with regard to injury were not consistent with a previous study showing that as the number of steps per day increased so did the injury rate. Differences in the measuring instruments (accelerometer vs. pedometer) or in the number of days over which the surveillance was conducted may partly account for the differences.

INTRODUCTION

US Army Basic Combat Training: Injury Incidence and Costs

The purpose of Basic Combat Training (BCT) is to develop basic soldiering skills and prepare recruits for the physical and mental rigors of military service. While military training is designed to enhance the physical fitness and military performance of the recruit, it can also produce less positive outcomes such as musculoskeletal injury. Training injuries can result in delayed graduation, attrition, and significant medical expenses. Ultimately, injuries can limit the number of deployable Soldiers.

The high rate of BCT injuries has a significant negative impact on military readiness, training costs, medical costs, lost duty days, recruit attrition and the number of deployable soldiers. A study of BCT at Ft Jackson, SC reported that 19% of recruits failed to complete training with their peers, 15% failed the APFT, and 29% suffered an overuse injury [11]. Over the past 30 years, the injury rates (% injured trainees per month) during Army BCT have ranged from 6% to 21% for men and 16% to 33% for women, with a median rate of about 13% for men and 28% for women [1-11,15-17]. Historically, the injury incidence of women tends to be twice that of men during BCT [1].

During the fiscal year 2012, the average cost of training a new Army recruit from the recruiting station through basic training until s/he reaches the first duty station was $74,800 [12]. This represents costs from US Army Recruiting Command (USAREC), US Military Entrance Processing Command (USMEPCOM), and US Army Training and Doctrine Command (TRADOC). The Army recruited approximately 75,000 enlistees in 2012 [12] . The average Army first 90-dayBCT attrition rate for FY2006-2011 was 6% -14% (13) by the end of first year of service. This equates to an estimated $300,000,000 first year loss (assuming $74K for both BCT & AIT training loss. This estimate does not include additional costs due to delayed graduation for injury/illness or recycling for performance issues.

The volume of PA and type of physical training appear to play a significant role in BCT musculoskeletal overuse injuries and recruit attrition [2]. The US Army has four basic training sites and there is a lack of information on exactly how much PA recruits are exposed to over the 10 weeks of BCT at each site. Although BCT graduation requirements are identical across posts, battalions and companies [14], the amount of time needed to teach the skills may vary. For instance, one company may spend more time on hand-to-hand combat and less time on drill and ceremony, depending on the time necessary for recruits to reach the required proficiency level. Some units may do more foot marches depending on the location of their barracks, available of motor transportation and distance to training sites. Physical Readiness Training (PRT) is the physical training program that is required by doctrine [15] but there is little information on whether or not BCT units are following this doctrine as proscribed. These and other situations could impact the amount and type of PA that recruits are exposed to. Because of the potential variability in how each group is trained (their PA exposure), it may be difficult for researchers to generalize conclusions from injury data taken from one BCT site to another. By quantifying the volume of PA, performance, and injuries incurred during the middle 8 weeks of BCT one may gain a better understanding into the relationship between these three factors.

Basic Combat Training Injury Risk Factors

Injury rates in BCT are influenced by extrinsic (training environment) and intrinsic (individual differences) risk factors. Extrinsic risk factors include high running mileage, summer season, and higher total ambulatory activity. Identified intrinsic risk factors include older age, female gender, low aerobic fitness, low muscular endurance, high and low extremes of flexibility, low levels of PA prior to BCT, cigarette smoking prior to BCT, and menstrual irregularities [1,2,16]. Less consistently demonstrated intrinsic risk factors include lower levels of muscular strength, higher body fat, and higher or lower body mass indices. Multivariate analyses have shown that cigarette smoking prior to BCT, low levels of aerobic fitness and low levels of PA prior to BCT are independent injury risk factors [1]. While some of the intrinsic risk factors are not easily modifiable, extrinsic factors are more amenable to intervention. One example of modifiable risk factors is the amount and types of physical training [1,18] and PA [2] recruits are exposed to during BCT. These factors appear to have a profound effect on the injury risk during training. It is therefore important to quantify the type and amount of PA recruits are exposed to during BCT.

Methods for Quantifying Physical Activity

Accelerometry

Accelerometers measure accelerations using the voltage signal of motion sensors after it is filtered, amplified and sampled at a prefixed frequency [19]. Accelerometers not only measure the total amount of activity via acceleration of the body but also allow for the characterization of the intensity, duration and frequency of activity. Sources of error for accelerometry data include factory calibration, proper positioning of the unit, and determining appropriate cutoff points for classifying counts into intensities of PA. The most frequently used accelerometer for scientific research is the ActiGraph, which utilizes a triaxial accelerometer capable of measuring accelerations in the vertical, anterior-posterior, and mediolateral axes. The ActiGraph was found to have the greatest intra- and inter-instrument reliability in a comparison of four different types of accelerometers [20].

The British Army utilized triaxial accelerometers to measure daily PA during weeks 1, 2, 6, 9, 13 and 14 of their 14 week gender-segregated basic training. Average daily physical activity count (PAC) was 13% lower for female (131,163±25,097 counts) than male recruits (148,537±30,189). The British Army study also found week 6, which included three physical training (PT) lessons, a drill test and a day on the marksmanship range, was the highest week in terms of PACs for both sexes [21].

Direct Systematic Observation of Physical Activity

During direct observation, a researcher observes and continuously records the PA of the subject. While direct observation is a common approach in behavioral science research, it has

been viewed as labor intensive (costly) and tedious [22] by PA researchers. Much time and effort are required to properly train observers to reliably code different PA variables. The tendency for subjects to change normal behavior when observed is also considered a limitation [23]. Despite these limitations, direct observation is considered one of the most valid, reliable, and objective methods of assessing PA [23]. To date, research and commercial product development endeavors to classify PA have been limited to systems that classify children's PA behavior. SOFIT (System for Observing Fitness Instruction Time) and BEACHES (Behaviors of Eating and Physical Activity for Children's Health) [24], utilize videotape and computerized touch screens for ease of use and analysis. The categories of PA are often broken down into a simplified list of lying down, sitting, standing, walking or very active. An Israeli Defense Forces study [25] investigated overuse injuries and PA in female infantry recruits during their 16-week BCT. Embedded trained observers (physical trainer reservists) followed the platoon of recruits and manually recorded daily PA in the following categories: standing, marching, running, training, and other. They found that recruit participation in walking, running, marching and calisthenics were less (60-80%) than planned, while standing was significantly greater (160-210%) than planned.

Self-Report Surveys

Self-report surveys have been advantageous for assessing PA in large epidemiological studies because they are relatively easy to administer, low in cost, and have low participant burden. The disadvantages of using self-report surveys lie in PA misrepresentation due to socially desirable responding, misinterpretation of questions, difficulties regarding time and intensity memory recall [26,27]. Recall surveys usually consist of 5-15 questions ranging from simple ordinal scales (e.g., 1-5 low to high PA) to summed score of continuous data (e.g., MET-min/day). Surveys generally take 5-10 minutes to complete and have been used for longer time frames of 1 wk, 1 mo, and 1 y [28]. Activity diaries generally provide a detailed accounting of virtually all PA performed, normally within a single day. Self-report logs differ from diaries in that each behavior during the day is generally not recorded. Instead, the duration of time spent in broad categories of activity (sitting, standing, walking) is recorded. For best results, it is recommended that recording in the PA log should be immediately after, shortly after, or at the end of the day [29].

Global Positioning System (GPS)

Attempts to monitor volunteer ambulation can be enhanced with commercially available Global Positioning System (GPS devices). GPS receivers allow accurate recording of movement distances and velocities by calculating the position of the receiver in relation to a system of navigation satellites. Previous research has reported portable GPS measurements are sufficiently precise to track participant movement and can be a valuable tool to complement accelerometer-based research [30].

Convergence studies

A review of the PA literature produced 25 articles regarding convergent validity of pedometers compared to accelerometers, direct observation, and self-reported measures.

Pedometers correlated strongly with uniaxial accelerometers as well as with time in observed activity [31]. Pedometer agreement with observation was highest during running, walking, or sitting, and displayed reduced accuracy during slow walking. Agreement with self-reported PA varied with the self-report instrument used, individuals assessed, and how pedometer outputs were expressed [31]. In another review of 138 studies, self-report measures produced higher activity levels than those directly measured by accelerometers [32]. Physical activity mode, intensity and duration can be captured and confirmed by combining indirect and direct measures of physical activity.

PURPOSES

Overall Purpose: To characterize the PA (amount, type and intensity) recruits perform during BCT and relate this to injuries and performance.

Purpose 1: To provide descriptive data on PA, APFT, attrition, and injury incidence during a BCT cycle needed to populate the TOP model

Purpose 2: To determine if the PA performed varies significantly between different BCT sites.

Purpose 3: To determine associations between various PA measurement instruments (accelerometer, direct observation, and PA log).

Purpose 4: To examine the association between activity levels and injuries during BCT.

METHODS

Study Design

This prospective observational study was conducted during the middle 8 weeks of the 10-week BCT course with the first iteration at Ft Jackson, SC from 7 June-13 August 2010 (414 men and 149 women) and the second iteration at Ft Sill, OK from 30 July-1 October 2011(476 men and 167 women). Six companies were tracked at Ft Jackson, and five batteries at Ft Sill. The term company is used for the Infantry, while the same sized unit for field artillery is called a battery (~200 Soldiers divided into four platoons). For simplicity, all will be referred to as companies for the rest of this report. The specific companies studied were selected by the commanding officers at the Brigade level of each post.

Volunteers completed an Injury Risk Factor Survey and were measured for body mass and stature. APFT scores were collected immediately following each test and injury data during training was collected from medical records. PA was measured using an accelerometer, direct observation, PA logs, and a GPS. Within each company, 24 recruits (6 per platoon) wore a triaxial accelerometer (ActiGraph) and filled out a PA Log at the end of each day. Of those 24, 4 also wore a GPS (1 per platoon) and one was selected for direct observation. .These procedures were followed Monday through Saturday beginning week 2 and ending after the Field Training Exercise in week 9. BCT recruits participate in nearly all activities as a company. For this reason, observations from the PAtracker (n=1), GPS (n=1), and averaged data from the accelerometers (n=24), and PA logs (n=24) were considered representative of the entire company sampled.

Basic Combat Training

A 10-week BCT cycle is divided into three phases (Red, White and Blue), each slightly longer than 3 weeks in duration. All phases included non-tactical road marches of varying length to and from training sites in which trainees marched in formation. The Red phase consists of introductory lessons in customs and courtesies, drill and ceremony, physical fitness, nutrition, first aid, wearing of the uniform, rifle maintenance, the manual of arms, and radio/telephone communication procedures. The white phase placed emphasis on basic rifle marksmanship, hand to hand combat, two tactical foot marches, and continued drill and ceremony training. The Blue phase consisted of combat maneuvers, live fire exercises, a three day field training exercise, hand grenade qualification, individual tactical training, and obstacle courses.

A typical training day began at 0500. The trainees dressed in PT uniform and performed PT for 1-2 hours. After PT, trainees returned to the barracks, performed hygiene, changed into Army combat uniforms, had a formation, and filed into the dining facility for breakfast. After breakfast, the training events of the day were conducted. Often these involved non-tactical road marches or motorized transportation to field training sites or classroom instruction in the battalion area. Lunch was generally served at 1200, either in the battalion dining facility or in the field. Training continued in the afternoon with dinner at about 1700. Generally training continued until about 2030, Trainees had personal time from 2030 to 2130 when lights went out. Generally, little or no training was conducted on Sunday.

Procedures

Height and Weight

Height (in) was measured using a stadiometer (GPM Instruments, Switzerland) and body mass (lbs) was measured using a digital scale (Secca, Germany). Height and weight were converted to meters and kilograms for reporting.

Injury Risk Factor Survey

To identify intrinsic and extrinsic risk factors of musculoskeletal injuries, all study volunteers completed the Injury Risk Factor Survey (Appendix A). The questionnaire included questions regarding a subject's height, weight, date of birth, tobacco use, PA participation prior to BCT, injury history and menstrual history.

Physical Activity Monitoring Methods

ActiGraph Accelerometer

The ActiGraph GT3X accelerometer provides a measure of the intensity and duration of daily PA and time spent in various body positions. The ActiGraph employs a triaxial accelerometer that senses acceleration along the vertical, anterior-posterior and mediolateral axes. The unit has a 4MB storage capacity, a 20-day battery life, and an inclinometer to determine subject posture and identify periods when the device has been removed. The GT3X weighs 27 grams and has an outside measurement of 1.5" x 1.44" x .70" (3.8cm x 3.7cm x 1.8cm). ActiGraph output is recorded in "counts," which are the summation of the absolute values of the sampled change in acceleration measured during a user defined measurement epoch. Activity intensity categories were defined as follows: sedentary to light intensity activity as 0 to 1951 counts·min^{-1}, moderate PA as 1952 to 5724 counts·min^{-1} and vigorous intensity PA as 5725 or more counts·min^{-1} [33].

Six recruits per platoon (24 Soldiers/company) were instrumented with an ActiGraph. At least one male and one female within each platoon wore a pouch containing the accelerometer mounted on a belt, with the accelerometer placed over their left hip. Recruits received verbal instructions on wearing the device. Generally, the ActiGraph was provided to the recruit at the morning formation at about 0500 hours, returned just before or just after the evening meal at about 1700-1800 hours. Times varied depending on the actual formation time and evening meals. If a recruit became injured, ill, or had to be separated from the platoon for a portion of the day while wearing the accelerometer, the accelerometer was worn by another recruit from the same training company.

At both sites, accelerometers were downloaded using the ActiLife5 software and exported into Microsoft Excel at the end of each day. From the accelerometers, the average daily time (min) recruits spent in each of four intensity categories were obtained: Sedentary, Light, Moderate and Vigorous. From the raw accelerometer outputs, the percent time (%T) recruits spent in each intensity category was calculated. These average daily values were then exported

into SPSS for statistical analysis. Any accelerometer data which deviated by ≥ 50% from their respective company mean on a given day was not considered in the analysis. Missing data was replaced with the mean values of the volunteer's respective company for that specific training day. An hour by hour mean was calculated based on the data for all the soldiers in each company. The data were then further reduced to daily average time (min) for each company.

PAtracker

The direct observation portion of this study employed the continuous duration recording method to characterize PA during BCT. Trained observers recorded changes in Soldier's PA as the change in activity occurred. A PA tracking software (PAtracker) was developed specifically for this task by USARIEM and L3 Communications-Jaycor (San Diego, CA). The PAtracker software was installed on a Smartphone. Soldier's activities were logged by selecting from a list of predetermined activities from the touch screen, at which time the software automatically added a time stamp and recorded each activity to a data file.

The type of activity was coded into the following body positions: lying, sitting, standing/on feet, kneeling, and varying. The times spent in the following PAs were also recorded: stationary, walking, running, cadence marching, crawling, combatives, obstacles, menial tasks, lifting/carrying and calisthenics. In addition, PA was classified by intensity and external load carried. Activity intensity was classified into the following categories: resting, light, moderate, vigorous, and maximum. A Work Intensity Scale was provided to observers. This scale was developed by USARIEM subject matter experts by considering common soldiering tasks in conjunction with the ACSM Guidelines for exercise prescription intensity levels [34], Actigraph cut points [33, 35], and The Compendium of PAs [36, 37]. External load was classified using the following categories: 0-10, 11-25, 26-50, 51-75 and >75(lbs.) by USARIEM subject matter experts by considering common soldiering tasks.

A team of two or three trained observers monitored and recorded the recruit's activity from first formation in the morning until the evening meal (typically about 12-14 hours). One Soldier from one platoon wearing an accelerometer and GPS was observed continuously. If the Solider was not participating in training (e.g., went to sick call, guard duty) another Soldier wearing an ActiGraph was observed.

Observer Training

Civilian contractors were hired and trained to be PA observers. All observers received a PA observation manual (see Appendix B) to review prior to training. The training manual included the operational definitions and examples for classifying PA. All observers received the recommended 10 hours of training for direct observation [24, 38]. The training included lectures, an explanation of PAtracker operating procedures, specific verbal and visual descriptions, examples of coding for each category, and hands-on practice observations with the PAtracker using prepared videos of Soldiers engaged in various PA as well as a one-hour simulated tracking practice session.

Several training videos were prepared in advance illustrating PA common to Soldiers. The training videos were rated by PA subject matter experts to establish a mutually agreed upon classification for activity type, body position, intensity, and load carried for each activity presented. Trainees' observational performances were measured against the training video. Any discrepancies in observer ratings were discussed and specific guidance was provided during the training sessions to address problem areas regarding properly classifying body position, activity, intensity, and load. Observers were provided with a wallet sized informational reminder card (see Figure 2) which listed the load (in pounds) of common equipment worn by Soldiers and activity intensity ranges.

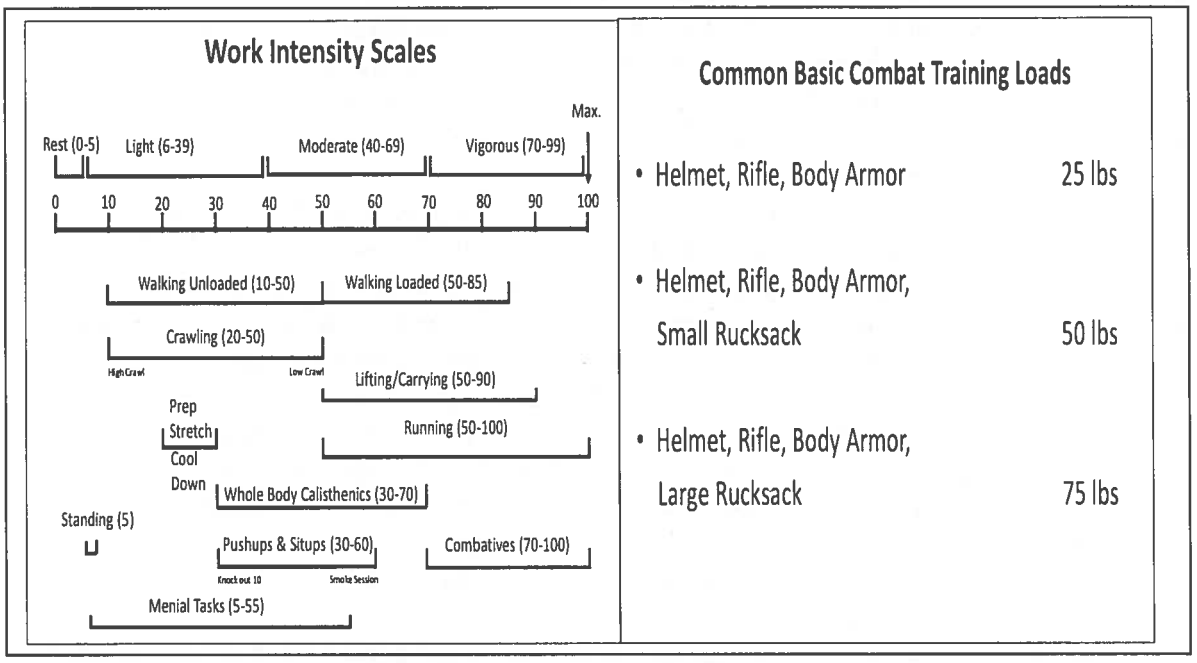


Figure 2. Work Intensity Scales and Common BCT Loads

24 hour Physical Activity Log

Each evening, all recruits wearing an accelerometer device (n=24 per company) completed a 24-hour PA log. The PA logs were a subjective measure of the PA the recruits participated in throughout the day. Physical activities were classified into the following categories; sleeping, sitting, standing, walking/marching, chores/tasks, calisthenics/obstacle course, running, and carrying a load. Recruits were asked to estimate the time spent performing each activity beginning with the previous night's sleep and ending when the device was turned in.

In the first iteration at Ft Jackson subjects were asked to estimate the amount (in lbs) of external load carried each day. At the second iteration at Ft Sill subjects were asked to estimate the amount of time spent in moderate to vigorous PA, but were not asked to estimate external load carried each day. In addition, Ft Sill subjects were given more specific directions to equate the total time reported in the first four categories (time spent sitting + standing + walking +

running) of PA log with the amount of time reported wearing the accelerometer (time = device put on minus device taken off). See Appendices C-E for full directions and actual PA Logs.

Daily average time and daily percent time spent in each PA category were calculated as well as time spent on feet, and time sedentary. Daily and training phase (Red, White & Blue), averages for companies and BCT sites were generated.

Global Positioning System (GPS)

One recruit from each platoon (4 recruits per company) at both Forts Jackson (n=24) and Sill (n=20) were equipped with a GPS device. From the GPS devices, information was obtained regarding the speed and distance covered by recruits during walks, runs and road marches. Raw data from the GPS devices was given to Massachusetts Institute of Technology's (MIT) Lincoln Laboratory for analysis. Since GPS data from Ft Sill was more complete than data from Ft Jackson, MIT Lincoln Laboratory concentrated their analyses on the Ft Sill data.

The GPS devices, cannot accurately record indoor movement (likely due to poor device reception) and periods where Soldiers were stationary (i.e. rest periods on hikes, calisthenics, etc). Researchers from MIT Lincoln Laboratory utilized an engineering-level Matlab software to distinguish between human and vehicular movement and to sort out anomalies in the GPS data. For these reasons, data included in this analysis only reflects outdoor walking and running at Ft. Sill. Analyses conducted by MIT Lincoln Laboratory involved spot-checking the GPS data by comparing it to data collected from the ActiGraph accelerometers and PAtracker device, as well as calculating descriptive statistics for distance traveled, duration and average speed for each training company.

Army Physical Fitness Test

During BCT, trainees took 4 scheduled fitness tests. The first test was the Fitness Assessment (1-1-1) taken within 1-3 days of arrival. The Fitness Assessment consisted of a 1-minute maximal effort push-ups event, a 1-minute maximal effort sit-up event, and a 1-mile run for time. The other 3 tests involved the standard Army Physical Fitness Test taken at Weeks 2, 5 and 7. The APFT consisted of a 2-minute maximal effort push-ups event, a 2-minute maximal effort sit-up event, and a 2-mile run for time. Both fitness tests were administered by drill sergeants who were familiar with the well-standardized test procedures. To meet the mandated BCT graduation requirement trainees had to "pass" the final APFT given on week 7. To "pass" the APFT, all trainees were required to meet certain age and gender adjusted criteria involving obtaining a minimum of 50 age- and gender-adjusted "points" on each test event [42]. A trainee who obtained 100 points on 2 events but 49 points on the third event was considered to have failed the APFT.

APFT data were obtained from the units and checked in the Resident Individual Tracking Management System (RITMS), which is a Training and Doctrine Command database. Missing data were verified or filled in by the company training non-commissioned officer or obtained from RITMS. Additional administrations taken at the end of BCT ('retakes') for volunteers who failed the final APFT were obtained to provide the final 'for record' score for each volunteer.

Injury Data

Study volunteers authorized access to their electronic medical information compiled in the Defense Medical Surveillance System (DMSS) to screen for injuries during the course of BCT. The Armed Forces Health Surveillance Center (AFHSC) regularly compiles data on ambulatory encounters that occur within military treatment facilities (MTFs), as well as those that occur outside the MTFs but paid for by the Department of Defense. To obtain DMSS injury data, the name, social security number, subject number, and inclusive dates of BCT for all consenting recruits was sent to the Armed Forces Health Surveillance Center (AFHSC). This was done two months after the completion of each BCT cycle (Nov 2010 for Ft Jackson volunteers and Dec 2011 for Ft Sill volunteers) to assure that all medical visits had been entered into the DMSS. The AFHSC returned visit dates and International Classification of Diseases, Revision 9, Clinical Modification (ICD-9-CM) codes for outpatient medical visits within the BCT time frames. The first four diagnoses for each visit were considered (although a single visit usually included only one diagnosis). An injury case was defined as a recruit who had a specific ICD-9-CM code that was included in one of five injury indices. These injury indices were the Installation Injury Index (III), the Modified Installation Injury Index (MIII), the Training Related Injury Index (TRII), the Overuse Injury Index (OII), and the Comprehensive Injury Index (CII) as described previously [11].

The III has been used to compare injury rates among different military posts and is reported on a monthly basis at the AFHSC website (http://afhsc.army.mil/), where the specific ICD-9-CM codes are also provided. The MIII is similar to the III but captures a greater number of overuse-type injuries (i.e., those resulting from cumulative microtrauma). The OII specifically captures the subset of both upper and lower body overuse-type musculoskeletal injuries and includes such diagnoses as stress fractures, stress reactions, tendonitis, bursitis, fasciitis, arthralgias, neuropathies, radiculopathies, shin splints, synovitis, and strains. The TRII is limited to lower extremity overuse injuries and has previously been used to compare injury rates among basic training posts. The CII captures all ICD-9-CM codes related to injuries, both traumatic and overuse. The CII attempts to include all injuries as classically defined in epidemiology as physical damage to the body as a result of an energy exchange [39].

Cumulative injury incidence (%) for each of the 5 injury indices were calculated as:

$$[(\sum \text{recruits with} \geq 1 \text{ injury visits} / (\sum \text{of all recruits})] \text{ X } 100\%.$$

Data Analysis

Physical Activity Analysis

Descriptive statistics (mean ± SD) were calculated by company and location for type, duration, and intensity of PA measured by electronic instrumentation, self-report and direct observation. Differences in time spent performing different types of PA, time and percent time spent performing PA at the various intensities were examined at the company levels with repeated measures and one-way analysis of variance. Significant differences between companies were examined using Tukey post-hoc tests.

Pearson product moment correlations were run to determine the strength of association between the ActiGraph and PAtracker on measures of intensity and between the PAtracker and the daily PA log on measures of body position and PA type. Absolute agreement between the measurement instruments was assessed using the Bland-Altman method [40] to determine if similar values for PA intensity, body position, and type of PA had been captured between 2 measurement instruments. First, differences in average daily time spent in each PA intensity, body position, or type of PA as measured by each instrument (ActiGraph, vigorous; PAtracker, vigorous) were plotted against their mean (mean of the average daily time obtained while in vigorous activity as measured by the ActiGraph and PAtracker). The data were then analyzed for the presence of heteroscedasticity by plotting the absolute values of individual differences between the 2 measurement instruments versus the means between the 2 instruments for PA intensity, body position, and type of PA [40, 41].

Data were defined as homoscedastic if R^2 <0.1, or as heteroscedastic if R^2 >0.1 [40, 41]. Significant Pearson product-moment correlation coefficients were considered indicative of heteroscedastic data (the random error increased as the average daily time increased). If the data were heteroscedastic, the 95% ratio limits of agreement (LoA) was calculated as follows:

95% ratio LoA=(SD of the difference scores ÷ average of the mean values)×1.96

If the data were homoscedastic, the 95% LoA was calculated as follows:
95% LoA=SD of the difference scores×1.96

The LoA indicates that the average daily time spent in PA intensity, the body position, or the type of PA obtained from the 2 measurement instruments will differ due to measurement error by no more than *X* average daily minutes (for LoA) or *X* % (for ratio LoA in either the positive or negative direction.11 Pearson correlations were performed with IBM SPSS Statistics (V 14.0) (IBM Corp, Chicago, IL) for Windows. Bland-Altman plots were performed with Microsoft Excel 2007.

Injury Measurement Analysis

To examine the association between PA and injuries, accelerometer data were truncated to equate the number of training days and hours of data collection at Ft Sill and Ft Jackson. Using independent sample t-tests, the daily average time (min) spent in accelerometer-determined sedentary, light, moderate, and vigorous activity was compared between locations. The total accelerometer counts were also compared between locations in the same manner.

In addition to the analysis by location, a separate analysis was performed comparing companies *within* locations. The time that companies spent in each accelerometer-determined activity intensity (sedentary, light, moderate, vigorous) were each placed into three subcategories based on ranking the amount of time spent at the activity intensity. At Ft Jackson, two companies were placed into a low activity subcategory, two into a moderate activity subcategory, and two into a high activity subcategory. At Ft Sill, two companies were placed into the high

and low activity subcategories while the moderate activity subcategory had a single company. The total accelerometer counts were treated in a similar manner. Differences in injury incidence between the subcategories were analyzed by comparing the injury risk at lower activity subcategory (baseline level) to the injury risk in the other two subcategories. Note that the companies placed into each accelerometer-determined activity intensities (sedentary, light, moderate, vigorous) differed because their rankings differed by activity level.

RESULTS

Subject Demographics

Overall, a total of 1,206 recruits from both Ft Jackson and Ft Sill volunteered to participate in the study. Of this sample, 46% were at Ft Jackson (n=563) while 54% were at Ft Sill (n=643). Recruits' age and measurements of height (m) and weight (kg) by gender for each BCT site are shown in Table 1. Women made up 26% of both the Ft Jackson and Ft Sill cohorts.

Table 1. Age (yr), Height (m), Weight (kg) and BMI (kg/m^2) by Gender at each Training Site.

	Ft Jackson (n=563)			Ft Sill (n=643)		
	Total (n=563)	**Men (n=414)**	**Women (n=149)**	**Total (n=643)**	**Men (n=476)**	**Women (n=167)**
Age (yr)	20.8 ± 4.0	20.8 ± 4.0	20.7 ± 3.6	20.8 ± 3.9	20.7 ± 3.8	21.2 ± 4.3
Height (m)	1.7 ± 0.1[μ]	1.8 ± 0.1[*]	1.6 ± 0.1	1.7 ± 0.1	1.8 ± 0.1[*]	1.6 ± 0.1
Weight (kg)	72.8 ± 13.8	78.3 ± 13.0[*]	62.6 ± 8.4	74.1 ± 14.2	78.9± 12.9[*]	63.6 ± 9.0
BMI (kg/m^2)	24.1 ± 3.6[μ]	25.2 ± 3.7[*]	23.8 ± 2.9	25.5 ± 4.8	25.5 ± 3.7[*]	24.1 ± 2.9

*Men vs. Women, $p<0.05$
[μ]Ft Jackson vs. Ft Sill, $p<0.05$

Injury Risk Factor Survey

Not all recruits answered all the questionnaire items. Thus, the number of recruits included in the analysis is shown for each questionnaire item.

Physical Activity History

When comparing themselves to others of the same age and gender as to the amount of PA performed prior to entering BCT, 35.7% (n=424) of the total study sample (n=1189) indicated they were *somewhat more active* than their peers, 26.7% (n=317) reported being *about the same,* 17.4% (n=207) reported being *somewhat less active*, 14.4% (n=171) reported *being much more active*, and 5.9% (n=70) reported being *much less active*. See Table 2 for further breakdown of the responses by BCT site and gender. A chi square analysis revealed a significant association between BCT site and PA prior to BCT for men (*p=0.020*) but not for women (*p=0.200*).

Among the men, the proportion of recruits reporting that they were *much less active* (5.4% vs. 4.4%) and *much more active* (17.1% vs. 14.7%) was roughly the same between locations. However, compared to Ft Sill, Ft Jackson had a larger proportion of male recruits reporting they were *somewhat less active* (19.6% vs. 13.4%) and fewer reporting they were *somewhat more active* (34.2% vs. 40.0%) prior to BCT. Overall, this suggests the Ft Jackson men were less active prior to BCT than the Ft Sill men.

Table 2. Frequency Distribution by Training Site and Gender in Response to the Question: "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 combat training?"

	% (n) Ft Jackson			% (n) Ft Sill		
	Total (n=546)	*Men (n=404)*	*Women (n=142)*	*Total (n=643)*	*Men (n=477)*	*Women (n=166)*
Much less active	7.7 (42)	5.4 (22)	14.1 (20)	4.4 (28)	3.6 (17)	6.6 (11)
Somewhat less active	19.2 (105)	19.6 (79)	18.3 (26)	15.9 (102)	13.4 (64)	22.9 (38)
The same	24.7 (135)	23.8 (96)	27.5 (39)	28.3 (182)	28.3 (135)	28.3 (47)
Somewhat more active	32.6 (178)	34.2 (138)	28.2 (40)	38.3 (246)	40.0 (191)	33.1 (55)
Much more active	15.8 (86)	17.1 (69)	12.0 (17)	13.2 (85)	14.7 (70)	9.0 (15)

The proportion of recruits who trained 3 or more days per week in the 30 days prior to BCT was 74.8% (n=891) for general exercise or sport, 55% (n=655) for running/jogging, and 44.1% (n=523) for weight training. See Table 3 for further breakdown of recruits' responses to these questions by BCT site. Significant effects of gender, but not BCT site, on the number of times per week recruits spent exercising/playing sports, running/jogging, and weight training prior to BCT were observed. Overall, there were differences between men and women ($p<.01$) in the times/week they exercised/played sports (5.9±2.0 vs. 5.2±2.0), ran/jogged (4.9±1.9 vs. 4.5±2.0), and weight trained (4.3±2.3 vs. 3.2±2.1).

Table 3. Percentage Distribution of how often (times/wk) recruits at both training sites reported Exercising/Playing Sports, Running/Jogging and Weight Training prior to entering Basic Combat Training

Frequency (times/wk)	Exercise/Sports Played %(n)			Run/Jog %(n)			Weight Train %(n)		
	Both (n=1190)	*Ft Jackson (n=547)*	*Ft Sill (n=643)*	*Both (n=1189)*	*Ft Jackson (n=546)*	*Ft Sill (n=643)*	*Both (n=1189)*	*Ft Jackson (n=547)*	*Ft Sill (n=642)*
Never	1.6 (19)	2.6 (14)	0.8 (5)	3.6 (43)	4.8 (27)	2.5 (16)	23.2 (276)	26.0 (142)	20.9 (134)
<1	7.3 (87)	4.8 (26)	9.5 (61)	9.0 (107)	9.0 (49)	9.0 (58)	9.1 (108)	9.3 (51)	8.9 (57)
1	3.6 (43)	7.9 (43)	0.0 (0)	10.7 (127)	10.6 (58)	10.7 (69)	8.7 (104)	7.9 (43)	9.5 (61)
2	12.6 (150)	13.0 (71)	12.3 (79)	21.6 (257)	21.1 (115)	22.1 (142)	15.0 (178)	15.5 (85)	14.5 (93)
3	19.8 (236)	18.6 (102)	20.8 (134)	24.3 (289)	23.3 (127)	25.2 (162)	17.8 (212)	16.3 (89)	19.2 (123)
4	16.6 (198)	15.9 (90)	16.8 (108)	12.2 (145)	11.4 (62)	12.9 (83)	9.8 (116)	9.7 (53)	9.8 (63)
5	18.6 (221)	16.8 (95)	19.6 (126)	9.9 (118)	9.7 (53)	10.0 (65)	9.7 (115)	9.9 (54)	9.5 (61)
6	9.3 (111)	7.7 (42)	10.7 (69)	4.1 (49)	4.6 (25)	3.7 (24)	2.8 (33)	2.2 (12)	3.3 (21)
7+	10.5 (125)	11.7 (64)	9.5 (61)	4.5 (54)	5.5 (30)	3.7 (24)	4.0 (47)	3.3 (18)	4.5 (29)

When asked to report how long they had been running prior to arriving at BCT, 20.9% (n=249) of the total study sample reported they had been running for <1 month while only 4.5% (n=54) reported they had been running for 7-11 months prior to arriving at BCT. When asked to report how long they had weight trained prior to BCT, 28.4% (n=336) of the total study sample reported not weight training at all, while only 4.0% (n=47) reported they weight trained for 7-11 months prior to entering BCT. See Table 4 for further breakdown of recruits' responses to these questions by BCT site. No significant effects of gender or BCT site on the number of months recruits spent running prior to BCT were observed. However, significant effects of gender, but not BCT site, were observed on the number of months recruits reported weight training prior to arriving at BCT. On average, men in this sample participated in weight training for a longer period of time prior to arriving at BCT than women (3.9±2.3 vs. 2.8±2.0 months/wk, p=0.000).

Table 4. Percentage Distribution of Frequency (months) of Running and Weight Training Prior to Entering Basic Combat Training for the Total Sample and by Training Site

	Run Pre-BCT, % (n)			Weight Train Pre-BCT, % (n)		
Frequency (Months)	*Both (n=1189)*	*Ft Jackson (n=546)*	*Ft Sill (n=643)*	*Both (n=1183)*	*Ft Jackson (n=546)*	*Ft Sill (n=637)*
Did not	7.5 (89)	8.4 (46)	6.7 (43)	28.4 (336)	31.1 (170)	26.1 (166)
<1 Month	20.9 (249)	19.8 (108)	21.9 (141)	14.8 (175)	12.8 (70)	16.5 (105)
2 Months	19.8 (235)	18.7 (102)	20.7 (133)	10.6 (125)	9.0 (49)	11.9 (76)
3 Months	14.7 (175)	14.5 (79)	14.9 (96)	7.7 (91)	9.2 (50)	6.4 (41)
4-6 Months	15.7 (187)	16.5 (90)	15.1 (97)	12.9 (153)	13.2 (72)	12.7 (81)
7-11 Months	4.5 (54)	3.8 (21)	5.1 (33)	4.0 (47)	4.0 (22)	3.9 (25)
12+ Months	16.8 (200)	18.3 (100)	15.6 (100)	21.6 (256)	20.7 (113)	22.4 (143)

Injury History

Frequencies of responses to questionnaire items related to prior injuries of the lower body are shown in Table 5. A significant effect of gender, but not BCT site, was observed on the injury history risk question relating to lower body injury. Overall, more men than women (31.1% vs. 24.5%, p=0.028) reported they had sustained a lower body injury at some point prior to arriving at BCT. There were no significant gender or BCT site differences on the other two questions.

Table 5. Injury History for the Total Sample and by Training Site

		Total Population,%(n)	Ft Jackson %(n)	Ft Sill %(n)
Have you ever injured one, or both, of your lower limbs, ankles or feet?				
	Yes	29.4 (349)	33.0 (180)	26.3 (169)
	No	70.6 (839)	67.0 (366)	73.7 (473)
Did any of these injuries prevent you from participating in your normal physical activities?				
	Yes	21.8 (260)	24.0 (132)	19.9 (128)
	No	12.9 (154)	16.6 (91)	9.8 (63)
	Not Applicable	65.2 (776)	59.3 (325)	70.2 (451)
Were you able to return to 100% of your normal physical activities following the injury?				
	Yes	28.9 (344)	32.1 (176)	26.2 (168)
	No	2.2 (26)	2.2 (12)	2.2 (14)
	Not Applicable	68.9 (820)	65.7 (360)	71.7 (460)

Tobacco Use History

Smoking history for all the recruits is broken down by training site and shown in Table 6. Significant effects of gender, but not BCT site, on these smoking history questions were observed. Of the entire study sample, more men than women (31.6% vs. 20.6%, p=0.000) reported smoking at least 100 cigarettes in their lifetime. Men in this sample also reported smoking more cigarettes per day than women (10.3±12.5 vs. 6.5±4.9 cigarettes/day, p=0.038).

Table 6. Smoking History Risk Factors for Total Sample and by Training Site

	Total (n=1191)	*Ft Jackson (n=548)*	*Ft Sill (n=643)*
Smoked 100 cigarettes in your lifetime?			
Yes [%(n)]	28.6 (341)	29.2 (160)	28.1 (181)
No [%(n)]	71.4 (850)	70.8 (388)	71.9 (462)
Age Smoked First Cigarette (yr)	16.1 ± 3.1	16.0 ± 3.4	16.2 ± 2.8
Smoking Frequency in the Last 30 Days (d)	16.1 ± 3.1	16.0 ± 3.4	16.2 ± 2.8
Cigarettes per Day ($n \cdot d^{-1}$)	9.6 ± 11.6	9.3 ± 10.9	10.0 ± 12.4
Time Since Quitting (months)	12.9 ± 22.3	11.8 ± 21.7	14.1 ± 22.8

Ft Jackson vs. Ft Sill, p>0.05 for all variables

Menstrual History

Frequencies of responses to questionnaire items related to menstrual history and birth control use for all the women who participated in the study as well as responses by training site are shown in Table 7. Overall, the average age of menarche was 12.7±1.9 yr. There was no difference in age of menarche between female recruits at Ft Jackson and Ft Sill (12.7±1.8 vs. 12.6±2.0 yr, p=0.745)

Table 7. Reproductive History Risk Factors for Female Recruits at Ft Jackson and Ft Sill

	Total % (n=311)	Ft Jackson % (n=144)	Ft Sill % (n=167)
Have you missed 6 or more months in a row between menstrual cycles?			
I have never had a menstrual period	9.0 (28)	12.5 (18)	6.0 (10)
Yes	7.4 (23)	11.8 (17)	3.6 (6)
No	83.6 (260)	75.7 (109)	90.4 (151)
In the last 12 months, have you taken birth control pills?			
Yes	41.7 (130)	49.3 (71)	35.9 (60)
No	57.7 (180)	50.7 (73)	64.1 (107)

Army Physical Fitness Test

Table 8 shows performance on the final APFT. Men at Ft Sill completed more push-ups (p=0.003) and accrued more points on the push-up component of the APFT (p=0.004) than men at Ft Jackson. There were no significant differences between men at Ft Sill and men at Ft Jackson on any other component of the APFT (p>0.05). Similarly, women at Ft Sill completed more push-ups (p=0.000) and accrued more points on the push-up component of the APFT (p=0.003) than women from Ft Jackson. There were no significant differences between women at Ft Sill and women at Ft Jackson on any other component of the APFT (p>0.05).

Table 8. Final Army Physical Fitness Test Scores by Training Site and Gender

	Ft Jackson		Ft Sill	
	Men (n=398)	*Women (n=133)*	*Men (n=453)*	*Women (n=155)*
Number of Push-ups	51.2 ± 13.5*	28.3 ± 11.5	54.1 ± 14.6*	33.5 ± 13.4
Push Up Points	72.1 ± 15.9	74.7 ± 16.5	75.3 ± 16.4*	80.8 ± 17.3
Number of Sit-ups	63.1 ± 11.1*	59.5 ± 12.3	64.0 ± 12.1	62.5 ± 13.8
Sit-up Points	76.3 ± 15.2*	70.7 ± 17.5	77.2 ± 16.0	74.3 ± 18.2
Run Time (min)	14.7 ± 1.4*	17.8 ± 2.2	14.8 ± 6.4*	17.8 ± 2.2
Run Points	77.6 ± 16.9*	73.3 ± 20.1	78.3 ± 17.9*	73.0 ± 20.9
Total Points	225.7 ± 38.6	218.1 ± 43.6	230.8 ± 40.5	228.1 ± 45.9
Final Outcome				
Pass [n(%)]	392 (98.5)	126 (94.7)	444 (98.0)	146 (94.2)
Fail [n(%)]	6 (1.5)	7 (5.3)	9 (2.0)	9 (5.8)

Men vs. Women, *p<0.05

Quantification of Physical Activity during Basic Combat Training

ActiGraph

Recruits wore the accelerometer a total of 47 days at Ft Jackson and 44 days at Ft Sill. Table 9 lists the cumulative time as well as the number of days recruits from both training sites spent in each intensity category measured by the accelerometer. On average, recruits at Ft Jackson wore the accelerometer for a longer period of time each day than recruits at Ft Sill (754.0±112.6 min·d^{-1} vs. 677.4±102.6 min·d^{-1}, p<0.001). Therefore, all accelerometer comparisons between the two training sites in this study were done using average daily percent time. The exception to this was time spent in moderate to vigorous intensity PA between 0500 and 0700 hours, which was examined using average daily minutes. This was to examine the time recruits were likely engaged in PRT.

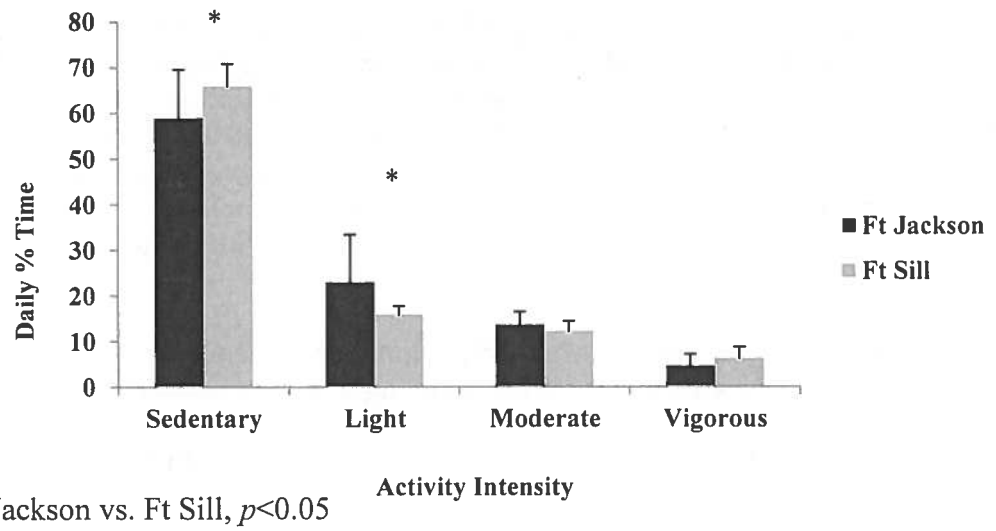
Table 9. Cumulative Time (min) Recruits at both Training Sites Spent in each Activity Intensity Category Measured with the ActiGraph during a Basic Combat Training Cycle.

	Ft Jackson			Ft Sill		
Days Recorded	47			44		
Total Time (min/hr) Recorded	35442.6±736.3 / 590.7±12.3			29806.9±1464.4 / 496.8±24.4		
Activity Intensity Categories	**Days***	**Time (min)**	**Time (hr)**	**Days***	**Time (min)**	**Time (hr)**
Sedentary	47	20847.5±702.7	347.5±11.7	44	19667.7±1558.6	327.8±26.0
Light	47	8193.6±512.8	136.6±8.5	44	4687.6±217.3	78.1±3.6
Moderate	47	4799.5±360.8	80.0±6.0	44	3624.3±357.6	60.4±6.0
Vigorous	47	1602.0±313.2	26.7±5.2	44	1827.4±207.9	30.5±3.5

**Days represent the total number of days recruits spent at a specific intensity level.*

Figure 3 shows the average daily percent time recruits from each training site spent in each activity intensity over the course of the BCT cycle. Recruits at Ft Jackson spent a larger percentage of their time engaged in light intensity activities (23.0±10.4% vs. 15.8±2.0%, p<0.001) and a smaller percentage of their time in sedentary activities (58.9±10.6% vs. 65.9±4.9%, p<0.001) when compared to recruits at Ft Sill. Additionally, recruits at both training sites spent most of their time (60-70%) in sedentary activities and less time (<10%) in vigorous activities.

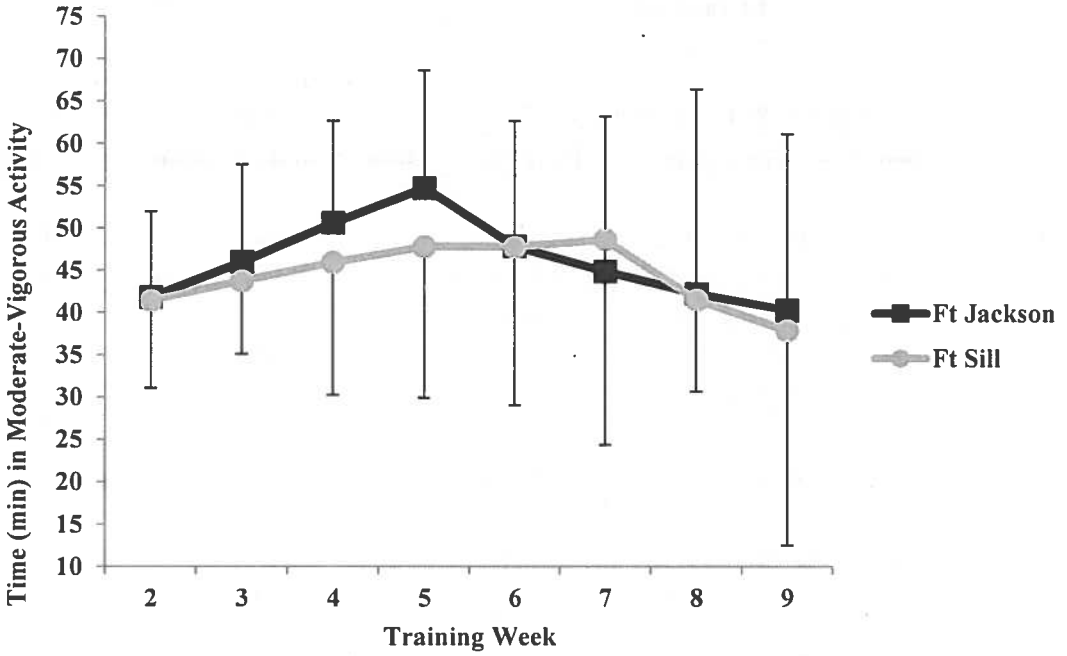
Figure 3. Average Daily Percent Time (±SD) Recruits Spent in each Activity Intensity Measured with the Accelerometer



*Ft Jackson vs. Ft Sill, $p<0.05$

Figure 4 shows the average daily time recruits at both training sites spent in moderate to vigorous intensity activity between 0500 and 0700 hours, when recruits were likely participating in PRT. Over the course of BCT, recruits at Ft Jackson spent an average of 46.1±4.9 $min \cdot d^{-1}$ while recruits at Ft Sill spent an average of 44.4±3.8 $min \cdot d^{-1}$ participating in moderate to vigorous intensity PA between 0500 and 0700 hours (p=0.443). Repeated measures analysis of variance indicated that time spent in moderate to vigorous intensity PA changed week to week at Ft Jackson (p=0.009), but did not significantly change week to week at Ft Sill (p=0.211).

Figure 4. Average Time (min, ± SD) by Training Week Recruits from Ft Jackson and Ft Sill Spent in Moderate-Vigorous Intensity Physical Activity between 0500 and 0700 hours as Measured with the Accelerometer.



See Appendix F for a further breakdown of the accelerometer data for each BCT site by training company.

PAtracker

Table 10 shows the number of days trained observers followed and observed recruits using the PAtracker. Table 10 also lists the average daily time recruits from both training sites spent in each body position, activity type, intensity, and carrying various external loads as measured with the PAtracker. Recruits were followed on average of 783.4±135.3 $min \cdot d^{-1}$ for 47 days at Ft Jackson and 708.9±128.5 $min \cdot d^{-1}$ for 44 days at Ft Sill ($p<0.001$). As was the case with the accelerometer, the recruits at Ft Jackson were observed with the PAtracker for a longer period of time each day than the recruits at Ft Sill. Therefore, all PAtracker comparisons between the two training sites in this study were done using average daily percent time.

Table 10. Cumulative Time Recruits at both Training Sites Spent in each Body Position, Activity Type, Activity Intensity and Carrying each External Load Measured with the PAtracker during a Basic Combat Training Cycle.

	Ft Jackson			Ft Sill		
Days Observed	47			44		
Time (min/hr) Observed	36463.2±8444.3 / 607.7±140.7			30367.2±8884.3 / 506.1±148.1		
	Days*	**Time (min)**	**Time (hr)**	**Days***	**Time (min)**	**Time (hr)**
Body Position						
Standing/On Feet	47	19216.3±476.2	320.3±7.9	44	19447.6±1752.5	324.1±29.2
Sitting	47	13187.2±1193.8	219.8±19.9	44	9374.1±1056.5	156.2±17.6
Lying	37	1071.8±284.0	17.9±4.7	37	943.0±184.9	15.7±3.1
Kneeling	34	409.2±172.7	6.8±2.9	37	602.5±252.2	10.0±4.2
Varying	41	2578.6±344.2	43.0±5.7	NA	NA	NA
Intensity						
Sedentary	47	19995.7±2902.8	333.3±48.4	44	14604.6±3835.6	243.4±63.9
Light	47	13126.8±1325.2	218.8±22.1	44	13506.0±3380.0	225.1±56.3
Moderate	44	2975.9±1333.2	49.6±22.2	40	2018.7±238.1	33.6±4.0
Vigorous	25	360.6±105.0	6.0±1.7	18	238.0±151.3	4.0±2.5
Activity Type						
Stationary	47	20402.9±1510.9	340.0±25.2	44	12871.7±2922.4	214.5±48.7
Menial Tasks	47	7925.0±495.2	132.1±8.3	44	11335.9±2180.3	188.9±36.3
Walking	47	4244.9±720.9	70.7±12.0	44	2606.8±435.2	43.4±7.3
Calisthenics	38	1391.9±146.6	23.2±2.4	39	1128.4±46.5	18.8±0.8
Cadence Marching	39	1195.6±325.0	19.9±5.4	40	1414.6±210.3	23.6±3.5
Combatives	12	559.6±155.3	9.3±2.6	4	113.5±75.9	1.9±1.3
Running	33	427.7±91.1	7.1±1.5	31	479.7±58.8	8.0±1.0
Obstacle/Climbing	7	181.0±55.7	3.0±0.9	8	302.4±38.8	5.0±0.6
Crawling	7	63.4±75.2	1.1±1.3	5	16.5±7.2	0.3±0.1
Lifting/Carrying	12	71.1±50.4	1.2±0.8	13	97.8±62.8	1.6±1.0
External Load						
0-10lbs	47	30533.1±2282.2	508.9±38.0	44	24323.4±859.1	405.4±14.3
10-25lbs	36	4585.4±1461.4	76.4±24.4	28	2869.6±1416.3	47.8±23.6
25-50lbs	19	1266.6±588.3	21.1±9.8	30	2796.2±628.6	46.6±10.5
50-75lbs	4	70.0±57.0	1.2±0.9	7	322.1±226.8	5.4±3.8
>75lbs	3	8.0±11.2	0.1±0.2	4	55.9±68.3	0.9±1.1

*Days represent the total number of days recruits participated in each body position, activity type and intensity and carried each load at least once.

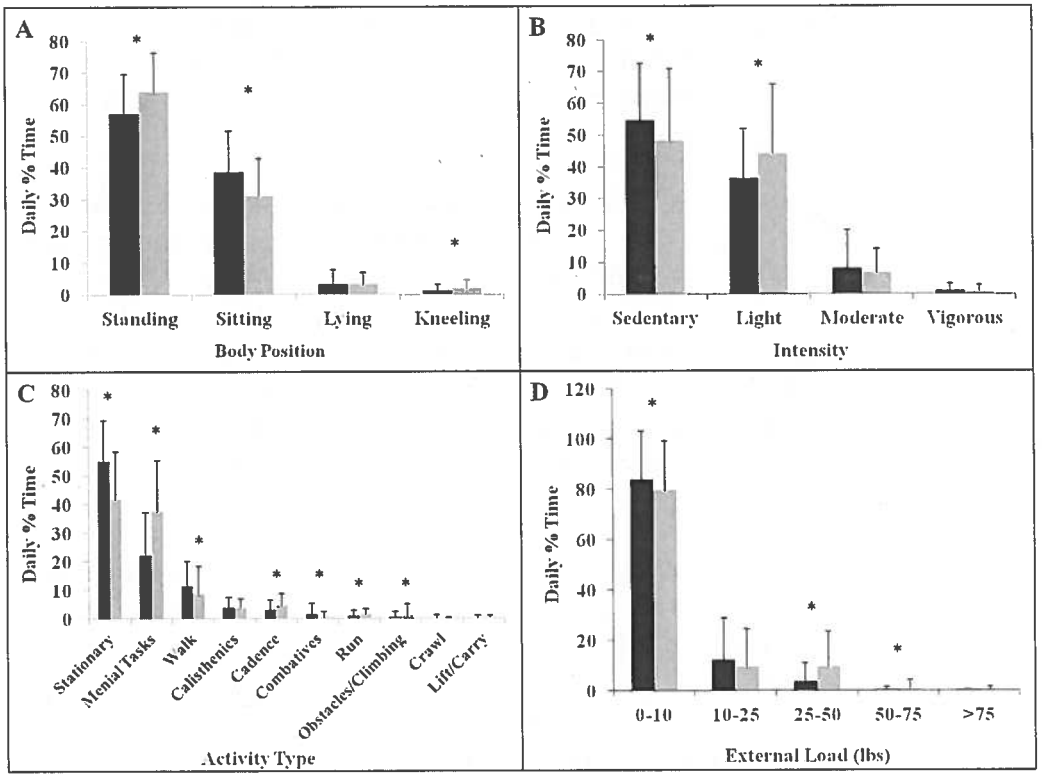
The average daily percent time recruits at Ft Jackson and Ft Sill spent in each body position is shown in Figure 5A. Recruits at Ft Jackson spent a larger percentage of time sitting (38.6±12.9% vs. 30.9±11.8%, $p<0.001$) and a smaller percentage of time kneeling (1.2±1.8% vs. 1.9±2.6%, $p<0.001$) and standing (57.0±12.6% vs. 64.0±12.2%, $p<0.001$) compared with recruits at Ft Sill. Little difference was observed in percent time recruits spent lying at both training sites (2.9±3.4% vs. 3.1±2.1%, $p=0.951$).

The average daily percent time recruits at Ft Jackson and Ft Sill spent in each activity intensity category is shown in Figure 5B. Recruits at Ft Jackson spent a larger percentage of time sedentary (54.5±18.1% vs. 48.2±22.6%, $p=0.001$) and a smaller percentage of time in light activities (36.5±15.5% vs. 44.1±21.8%, $p<0.001$) when compared to recruits at Ft Sill. Little difference was observed between the two training sites in terms of percentage of time spent in moderate (8.0±11.9% vs. 6.8±7.3%, $p=0.193$) or vigorous (1.1±2.3% vs. 0.9±1.9%, $p=0.290$) activities. As was the case with the accelerometer, recruits at both training sites spent a large percentage of time (about 50%) in sedentary activities and a small percentage of time (about 1%) in vigorous activities.

Figure 5C shows the average daily percent time recruits at both Ft Jackson and Ft Sill spent in different types of activities. Recruits at Ft Jackson spent a larger percentage of time engaging in combatives (1.6±4.0% vs. 0.4±2.0%, $p<0.001$), being stationary (55.1±14.3% vs. 41.8±16.8%, $p<0.001$), and walking (11.6±8.5% vs. 8.6±9.7%, $p<0.001$) and a smaller percentage of time cadence marching (3.3±3.3% vs. 4.7±4.0%, $p<0.001$), completing obstacles (0.5±2.1% vs. 1.1±4.0%, $p=0.030$), performing menial tasks (22.3±15.0% vs. 37.6±17.9%, $p<0.001$), and running (1.2±1.7% vs. 1.6±2.0%, $p=0.037$) when compared to recruits at Ft Sill. Little difference was observed between the two training sites in terms of percentage of time recruits spent in calisthenics (3.9±3.6% vs. 3.8±3.0%, $p=0.700$), crawling (0.2±1.1% vs. 0.1±0.3%, $p=0.102$), and lifting/carrying (0.2±0.9% vs. 0.3±0.8%, $p=0.097$).

The average daily percent time recruits at both training sites spent carrying various external loads over the course of a BCT cycle is shown in Figure 5D. Recruits at Ft Jackson spent a larger percentage of time carrying 0-10lbs (84.0±19.0% vs. 79.6±19.7%, $p=0.011$) and a smaller percentage of time carrying 25-50lbs (3.5±7.5% vs. 9.7±13.6%, $p<0.001$) and 50-75lbs (0.2±1.2% vs. 1.0±3.2%, $p<0.001$). Little difference was observed between the two training sites in terms of percentage of time recruits spent carrying 10-25lbs (12.2±16.6% vs. 9.6±14.8%, $p=0.066$) or greater than 75lbs (0.1±0.3% vs. 0.2±1.3%, $p=0.064$). Recruits at both training sites spent a large percentage of time (about 80%) carrying 0-10lbs and a very small percentage of time (≤1%) carrying over 50lbs.

Figure 5. Average Daily Percent Time Recruits from Ft Jackson (Black) and Ft Sill (Grey) Spent in Various Body Positions (A), Activity Intensities (B), Activity Types (C) and Carrying Various External Loads (D) Measured with the PAtracker.



*Ft Jackson vs. Ft Sill, $p<0.05$

24 Hour Physical Activity Log

Table 11 lists the cumulative time (hours and minutes) recruits from both training sites reported sitting, standing, walking, running, participating in calisthenics, doing chores and carrying loads based on the daily PA logs. Recruits at Ft Jackson self-reported total time in PA for an average of 601.1±52.5 min·d^{-1} for 47 days, while recruits at Ft Sill self-reported total time in PA for an average of 672.7±28.3 min·d^{-1} for 44 days ($p<0.001$). Recruits at Ft Sill self-reported more time in PA each day than recruits at Ft Jackson. Therefore, all PA Log comparisons between the two training sites in this study were done using average daily percent time, except time spent sleeping each night.

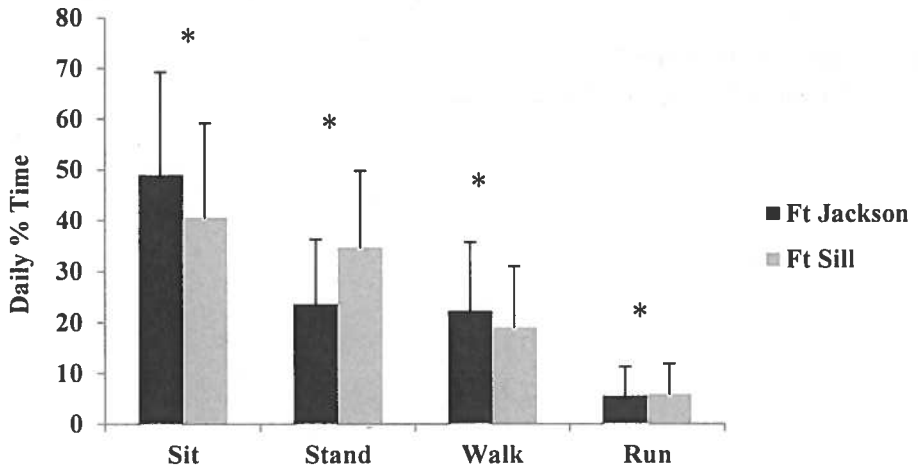
Table 11. Cumulative Time (mean ± SD) Recruits at both Training Sites Spent in Various Physical Activities Reported on the Daily PA Logs during a Basic Combat Training Cycle.

	Ft Jackson			Ft Sill		
Days Self-Reported Time (min/hr) Self-Reported	47 28256.2±1458.5 / 470.9±24.3			44 29597.6±596.2 / 493.3±9.9		
	Days*	**Time (min)**	**Time (hr)**	**Days***	**Time (min)**	**Time (hr)**
Sit	47	13672.7±1620.9	227.9±27.0	44	12430.8±1296.4	207.2±21.6
Stand	47	6848.0±743.8	114.1±12.4	44	9907.6±1233.9	165.1±20.6
Walk/March	47	6204.5±1204.6	103.4±20.1	44	5506.4±392.2	91.8±6.5
Run	47	1531.0±263.6	25.5±4.4	44	1752.8±238.9	29.2±4.0
Sleeping	47	17140.7±985.7	285.7±16.4	44	16569.4±567.7	276.2±9.5
Chores/Barracks Maintenance	43	1256.7±323.4	20.9±5.4	44	1135.4±321.5	18.9±5.4
Calisthenics/Obstacle Course	45	2795.5±669.0	46.6±11.2	44	2532.8±473.7	42.2±7.9
Carrying Load	46	4857.8±1738.4	81.0±29.0	44	2336.0±289.2	38.9±4.8

*Days represent the total number of days recruits participated in each variable at least once.

The average daily percent time recruits from both training sites reported sitting, standing, walking and running is shown in Figure 6. Recruits at Ft Jackson reported spending a larger percentage of time sitting (48.7±13.6% vs. 42.2±5.7%, $p<0.001$) and walking (21.8±8.7% vs. 18.5±2.7%, $p<0.001$), and a smaller percentage of time standing (24.0±7.3% vs. 33.5±4.8%, $p<0.001$) and running (5.4±3.2% vs. 5.9±1.5%, $p=0.034$) than recruits at Ft Sill.

Figure 6. Average Daily Percent Time Recruits from both Training Sites Reported they Spent Sitting, Standing, Walking and Running on the Daily Physical Activity Logs



*Ft Jackson vs. Ft Sill, p<0.05

Over the course of BCT, recruits at Ft Jackson reported spending less time sleeping each night than recruits at Ft Sill (364.7±41.1 min·night^{-1} vs. 376.6±17.5 min·night^{-1}, p<0.001). Recruits at Ft Jackson also reported spending a larger percentage of time doing chores (4.5±2.8% vs. 3.8±1.3%, p=0.002), performing calisthenics (10.0±7.7% vs. 8.6±2.5%, p=0.006) and carrying loads (16.9±12.8% vs. 7.9±2.4%, p<0.001) than recruits at Ft Sill.

See Appendices G and H for a further breakdown of PA log data by training company.

Associations between Measurement Methods

Weak but positive Pearson correlations (r = -.05 to .30) were found between the ActiGraph and PAtracker for average daily time spent in sedentary, moderate, and vigorous PA. Alternatively, the association was negative and weak for average daily time spent in light PA (Table 12). The 95% LoA analyses for intensity measurements between the ActiGraph and PAtracker were heteroscedastic; the ratio LoA are provided in Table 12.

Table 12. Comparisons of time (min ± SD) spent in various PA intensities between the

Measure	Avg. Daily Min ActiGraph	Avg. Daily Min PAtracker	Difference Avg. Daily Min	Pearson Correlation (r)	Ratio LoA (%)	Under/Over reporting
A-T Sed	445 ± 93	393 ± 52	-52	.30**	81	T Under
A-T Light	144 ± 73	295 ± 139	151	-.05	143	T Over
A-T Mod	93 ± 25	56 ± 80	-37	.21**	208	T Under
A-T Vig	37 ± 19	7.1 ± 14	-30	.08	202	T Under
A-T ModVig	131 ± 35	63 ± 83	-68	.28**	163	T Under

ActiGraph (A) and PAtracker (T)
Accelerometer (A) and PAtracker (T)

**p<.01

Weak but positive Pearson correlations (r = .033 to .268) were found between the PAtracker and daily PA log for body position and type of PA (Table 13). The 95% LoA analyses for the PAtracker and daily PA log for the body positions of standing and running were heteroscedastic (Table 13). The 95% LoA analyses for walking and sitting were homoscedastic (Table 13). For sitting, the mean bias line (----) (31.7) and random error lines (····) (259,-195) forming the 95% limits of agreement are presented on the Figure 7 plot. For walking, the mean bias line (----) (74.0) and random error lines (····) (196,-93) forming the 95% limits of agreement are presented on the Figure 8 plot.

Table 13. Comparisons of daily average time spent in various body positions and PA types between the PAtracker (T) and PA Log (L) during a Basic Combat Training cycle

Measure	Avg. Daily Min PA-tracker	Avg. Daily Min PA Log	Difference Avg. Daily Min	Pearson Cor-relation	95% LoA (mins/ day)	Ratio LoA (%)	Under/ Over Reporting
T-L Stand	432 ± 119	180 ± 57	-252	.144**		79	L Under
T-L Sit	255 ± 108	287 ± 66	32	.186**	227.3		L Over
T-L Walk	78 ± 69	129 ± 44	51	.198**	145.0		L Over
T-L Run	10 ± 13	36 ± 16	26	.268**		153	L Over
T-L Menial Chores	212 ± 127	26 ± 14	-186	.033		209	L Under
T-L Calisthenics	29 ± 25	59 ± 35	30	.150**		177	L Over
T-L Carry Load	755 ± 81	139 ± 66	-674	.040		65	L Under

PA Log (L) and PAtracker (T)
Homoscedastic = Shaded area, Heteroscadastic = unshaded area

**$p < .01$

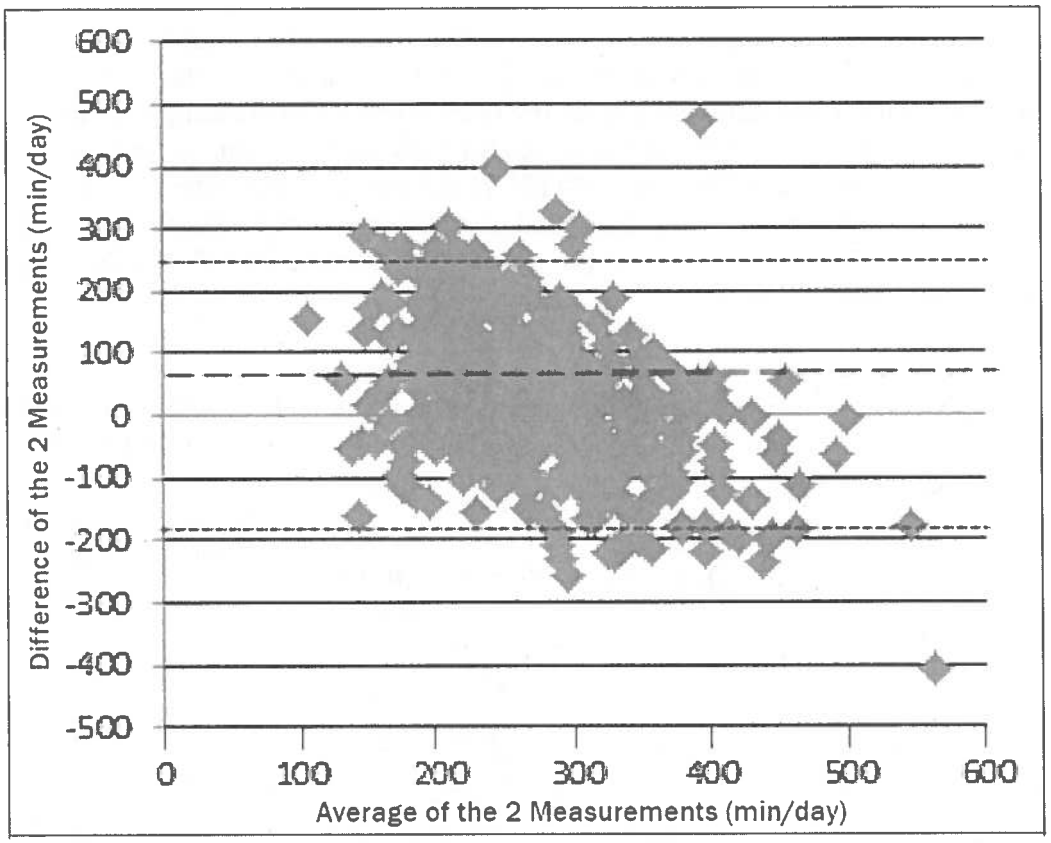


Figure 7. Bland-Altman plots of time spent sitting each day between the PAtracker and Physical Activity Log methods.

Legend:

— — — Mean bias line (31.7)

------- Random error lines (259, -195)

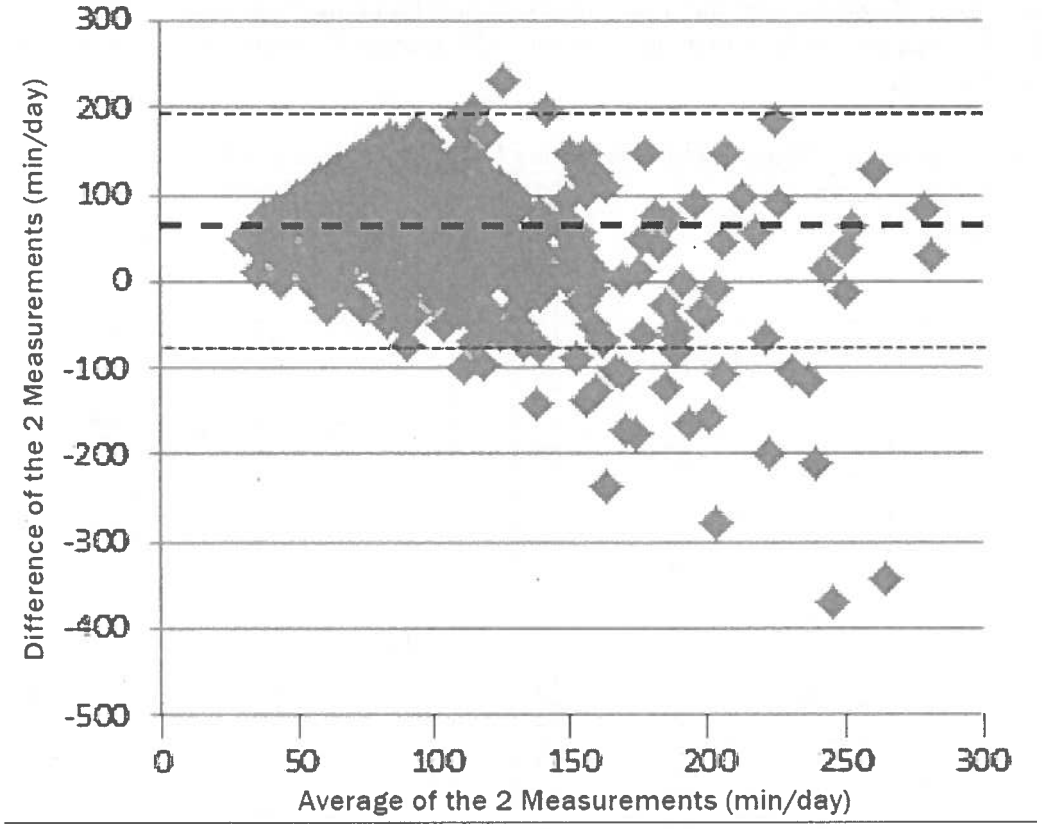


Figure 8. Bland-Altman plots of the time spent walking each day between the PAtracker and Physical Activity Log methods

Legend:
Mean bias line (74.0)
Random error lines (196, -93)

GPS

Due to inconsistent and incomplete data collection, the GPS technique was not a viable option to assist with the quantification of daily PA during BCT. Methodology was reported earlier and the FT Sill running data results have been placed in Appendix I. The difficulty to obtain full day data may be due to limited satellite coverage as volunteers often went in and out of buildings.

Association between Injury and Physical Activity

Injury data were obtained for 415 men and 148 women at Ft Jackson and 476 men and 166 women at Ft Sill. Table 14 shows a comparison of the injury incidence among companies within location. Although there were differences in injury incidence among companies, none of these reached the 0.10 level of statistical significance. Table 15 summarizes the injury incidence

data by location. Regardless of the injury index, injury incidence was much lower at Ft Sill compared to Ft Jackson for both men and women. Differences between locations were larger for women than for men.

Table 14. Comparison of Injury Incidence among Companies for Each Injury Index

Location	Injury Index	Company	Men			Women		
			N	Injury Incidence (%)	p-value[a]	N	Injury Incidence (%)	p-value[a]
Ft Jackson	III	1	88	18.2	0.20	30	63.3	0.42
		2	52	26.9		18	53.3	
		3	74	31.1		27	44.4	
		4	67	28.4		21	57.1	
		5	79	19.0		17	47.1	
		6	55	32.7		35	48.6	
	MII	1	88	22.7	0.13	30	66.7	0.65
		2	52	30.8		18	33.3	
		3	74	35.1		27	48.1	
		4	67	34.3		21	61.9	
		5	79	24.1		17	47.1	
		6	55	34.5		35	51.4	
	OII	1	88	14.8	0.34	30	53.3	0.28
		2	52	26.9		18	33.3	
		3	74	28.4		27	33.3	
		4	67	19.4		21	47.6	
		5	79	16.5		17	41.2	
		6	55	29.1		35	45.7	
	TRII	1	88	12.5	0.20	30	46.7	0.80
		2	52	19.2		18	33.3	
		3	74	21.6		27	37.0	
		4	67	14.9		21	52.4	
		5	79	11.4		17	41.2	
		6	55	25.5		35	37.1	
	CII	1	88	27.3	0.28	30	70.0	0.22
		2	52	32.7		18	33.3	
		3	74	39.2		27	48.1	
		4	67	35.8		21	61.9	
		5	79	24.1		17	52.9	
		6	55	38.2		35	54.3	
Ft Sill	III	7	89	21.3	0.53	18	38.9	0.46
		8	131	21.4		27	29.6	
		9	58	12.1		23	17.4	
		10	123	17.1		37	37.8	
		11	75	21.3		61	36.1	
		7	89	22.5		18	50.0	

	MIII	8	131	22.9	0.46	27	29.6	0.21
		9	58	12.1		23	17.4	
		10	123	20.3		37	40.5	
		11	75	24.0		61	37.7	
	OII	7	89	16.9	0.42	18	38.9	0.18
		8	131	16.8		27	22.2	
		9	58	6.9		23	8.7	
		10	123	16.3		37	32.4	
		11	75	13.3		61	24.6	
	TRII	7	89	14.6	0.29	18	33.3	0.35
		8	131	16.8		27	18.5	
		9	58	5.2		23	8.7	
		10	123	12.2		37	24.3	
		11	75	13.3		61	26.2	
	CII	7	89	23.6	0.44	18	50.0	0.19
		8	131	22.9		27	29.6	
		9	58	12.1		23	17.4	
		10	123	21.1		37	40.5	
		11	75	24.0		61	39.3	

[a]Chi-square statistic

Table 15. Comparison of Injury Incidence by Location for Each Injury Index

Gender	Injury Index	Injury Incidence (%)		Risk Ratio - Jackson/Sill (95% CI)	p-value[a]
		Ft Jackson	Ft Sill		
Men (Ft Jackson n=415 Ft Sill n=476)	III	25.3	19.1	1.32 (1.03-1.70)	0.03
	MIII	29.6	21.0	1.41 (1.12-1.77)	<0.01
	OII	21.7	14.9	1.45 (1.10-1.93)	<0.01
	TRII	16.9	13.2	1.27 (0.93-1.74)	0.13
	CII	32.3	21.4	1.51 (1.21-1.88)	<0.01
Women (Ft Jackson n=148 Ft Sill n=166)	III	50.0	33.1	1.51 (1.15-1.98)	<0.01
	MIII	52.7	35.5	1.48 (1.15-1.91)	<0.01
	OII	43.2	25.3	1.71 (1.24-2.35)	<0.01
	TRII	41.2	22.9	1.80 (1.28-2.53)	<0.01
	CII	54.7	36.1	1.51 (1.18-1.94)	<0.01

[a]Chi-square statistic

As noted in the methods, accelerometer data were truncated to equate the number of training days and hours of data collection at Ft Sill and Ft Jackson. Forty-four training days were available for all training companies. The training days and the number of Sundays and holidays where data was not collected are shown in Table 16. The total number of training days for Fort Jackson was thus 264 days (six companies) while 220 days were considered at Fort Sill (five companies).

Table 16. Training Days Considered in Injury Data

Location	Company	Training Days	Sundays and Holidays
Fort Jackson	A 2/39th	7 through 57	7
	B 2/39th	8 through 58	7
	C 2/39th	7 through 57	7
	D 2/39th	8 through 59	8
	E 2/39th	6 through 57	8
	F 2/39th	6 through 57	8
Fort Sill	B 1/79th	7 through 58	8
	D 1/19th	6 through 57	8
	E 1/19th	7 through 58	8
	E 1/40th	7 through 58	8
	E 1/79th	7 through 58	8

Table 17 shows the times at the various activity levels in the truncated data at Ft Jackson and Ft Sill. Recruits at Ft Sill spent more time in sedentary and vigorous activity, while Ft Jackson recruits spent more time in light and moderate activity. Nonetheless, total accelerometer counts differed little between locations.

Table 17. Time in each Activity Intensity for Recruits at Ft Jackson and Ft Sill (Truncated Accelerometer Data)

Activity Level	Fort Jackson Mean±SD Daily Activity	Fort Sill Mean±SD Daily Activity	p-value[a]
Sedentary Activity (min)	364±90	404±66	<0.01
Light Activity (min)	153±73	97±20	<0.01
Moderate Activity (min)	83±21	73±19	<0.01
Vigorous Activity (min)	27±16	35±16	<0.01
Total Accelerometer (counts)	342,451±99,430	358,413±123,666	0.12

[a]Independent samples t-test

Table 18 shows a comparison of injury incidence in the activity subcategories for total accelerometer counts. There was little relationship between the activity subcategories for men at Ft Jackson or Ft Sill or among the women at Ft Jackson. Among women at Ft Sill, those with lower accelerometer counts had a higher injury risk than those in the moderate or high categories.

Table 18. Comparison of Injury Incidence (CII) Across Various Activity Categories for Total Accelerometer Counts

Location	Activity Sub-Category	Mean±SD Daily Activity (Counts)	Men				Women			
			n	Injured (%)	Risk Ratio (95%CI)	p-value[a]	n	Injured (%)	Risk Ratio (95%CI)	p-value[a]
Fort Jackson	Low	309,567±86,903	140	29.3	1.00	Ref	48	56.3	1.00	Ref
	Mod	342,966±93,889	129	38.8	1.32 (0.95-1.85)	0.10	62	51.6	0.92 (0.65-1.30)	0.63
	High	374,823±106,607	146	29.5	1.00 (0.70-1.43)	0.99	38	57.9	1.03 (0.71-1.49)	0.88
Fort Sill	Low	330,120±110,055	212	22.2	1.00	Ref	55	43.6	1.00	Ref
	Mod	359,665±118,076	58	12.1	0.54 (0.26-1.14)	0.09	23	17.4	0.30 (0.12-0.75)	<0.01
	High	386,082±133,824	206	23.3	1.05 (0.74-1.50)	0.78	88	36.4	0.63 (0.45-0.89)	<0.01

[a]Chi-square statistic
Abbreviations: Mod=moderate, SD=standard deviation, CI=confidence interval

Table 19 shows a comparison of injury incidence across various activity subcategories for each activity intensity *within* each location. The activity subcategories were determined by dividing the total accelerometer counts into tertiles. There was little relationship between activity subcategories and injury risk at any activity intensity. Notable is a trend at Ft Sill for companies in the moderate and high category for vigorous intensity to have a higher injury incidence than those in the low activity category. However, this trend was not seen at Ft Jackson.

Table 19. Comparison of Injury Incidence (CII) Across Various Activity Subcategories for Each Activity Intensity

Location	Activity Level	Activity Sub-Category	Mean ±SD Daily Activity (min)	Men				Women			
				n	Injured (%)	Risk Ratio (95%CI)	p-value[a]	n	Injured (%)	Risk Ratio (95%CI)	p-value[a]
Fort Jackson	Sedentary	Low	354±87	141	37.6	1.00	Ref	48	54.2	1.00	Ref
		Mod	366±89	131	27.5	0.73 (0.51-1.04)	0.08	35	42.9	0.79 (0.50-1.26)	0.31
		High	372±95	143	31.5	0.84 (0.61-1.15)	0.28	65	61.5	1.14 (0.82-1.57)	0.43
	Light	Low	146±69	134	29.9	1.00	Ref	52	53.8	1.00	Ref
		Mod	155±75	141	37.6	1.26 (0.90-1.76)	0.18	48	54.2	1.01 (0.70-1.45)	0.97
		High	159±76	140	29.3	0.98 (0.68-1.41)	0.92	48	56.3	1.05 (0.73-1.49)	0.81
	Moderate	Low	78±19	140	29.3	1.00	Ref	48	56.3	1.00	Ref
		Mod	82±20	134	29.9	1.02 (0.71-1.47)	0.92	52	53.8	0.96 (0.67-1.36)	0.81
		High	88±21	141	37.6	1.28 (0.92-1.79)	0.14	48	54.2	0.96 (0.67-1.38)	0.83
	Vigorous	Low	21±11	162	32.7	1.00	Ref	57	59.6	1.00	Ref
		Mod	24±11	107	35.5	1.09 (0.77-1.52)	0.64	53	47.2	0.79 (0.55-1.13)	0.19
		High	35±20	146	29.5	0.90 (0.64-1.26)	0.54	38	57.9	0.97 (0.69-1.37	0.86
Fort Sill	Sedentary	Low	394±67	206	23.3	1.00		88	36.4	1.00	Ref
		Mod	396±66	58	12.1	0.52 (0.25-1.08)	0.06	23	17.4	0.48 (0.19-1.22)	0.08
		High	417±64	212	22.2	0.95 (0.67-1.36)	0.78	55	43.6	1.20 (0.80-1.81)	0.39
	Light	Low	92±19	254	22.0	1.00	Ref	64	35.9	1.00	Ref
		Mod	98±22	75	24.0	1.09 (0.68-1.73)	0.72	61	39.3	1.10 (0.70-1.72)	0.69
		High	101±18	147	19.0	0.86 (0.58-1.30)	0.48	41	31.7	0.88 (0.51-1.54)	0.66

	Moderate	Low	66±18	254	22.0	1.00	Ref	64	35.9	1.00	Ref
		Mod	75±18	75	24.0	1.09 (0.68-1.73)	0.72	61	39.3	1.10 (0.70-1.72)	0.69
		High	80±19	147	19.0	0.86 (0.58-1.30)	0.48	41	31.7	0.88 (0.51-1.54)	0.66
	Vigorous	Low	31±13	147	19.0	1.00	Ref	41	31.7	1.00	Ref
		Mod	32±15	123	21.1	1.11 (0.69-1.79)	0.66	37	40.5	1.28 (0.71-2.32)	0.42
		High	41±18	206	23.3	1.22 (0.81-1.85)	0.33	88	36.4	1.15 (0.68-1.94)	0.61

[a]Chi-square statistic
Abbreviations: Ref=reference level, Mod=moderate, SD=standard deviation, CI=confidence interval

DISCUSSION

To the best of our knowledge, this study was the first to characterize and quantify the amount of PA recruits actually perform during BCT at two different training sites. The results of this study revealed that, although there were some differences between the two sites in terms of PA performed, the differences were, for the most part, small and likely have little practical importance. Furthermore, it appeared that the intensity and types of PA were similar at the two sites.

Physical Activity Quantification

The primary purpose of this study was to characterize and quantify PA performed by recruits during the middle 8-weeks of BCT and determine whether or not there were differences in PA between training sites. PA performed by recruits was characterized and quantified using accelerometry, direct observation and daily PA logs. Despite statistical significance, the differences in PA observed between the two BCT sites were small. The magnitude of the differences between sites can be appreciated by examining the range of differences (lowest and highest) in average daily time spent in various PAs. From the accelerometer, the smallest difference was 7% (3.4 min/day) for sedentary activities and the largest difference was 7.2% (67.8 min/day) for light intensity activities. From the PAtracker, the smallest difference between the two training sites was 0.4% (2 min/day) for running and the largest difference was 15.3% (93.7 min/day) for menial tasks. From the PA Log, the smallest difference between the two training sites was 0.5% (7.2 min/day) for running and largest, 9.0% (50.3 min/day) for carrying loads. This suggests that US Army BCT recruits spent similar amounts of time in each PA intensity, activity type, body position, and carrying various external loads at the two locations tested. Whether or not this applies to all BCT sites will need to be determined with future studies.

In terms of intensity, the results of this study were the same regardless of the technique used to measure PA intensity (i.e. accelerometer or direct observation). Recruits at both training sites spent a very large percentage of time sedentary (about 80%) and a very small percentage of time in vigorous intensity activities (about 5%). Additionally, there was little difference between the two training sites in percent time recruits spent in moderate or vigorous intensity PA. These results further support the idea that the PA intensity at each training site was similar.

External loads carried by recruits were obtained from direct observation (PAtracker). Recruits from both training sites spent a very large percentage of time (roughly 80%) unloaded or carrying very light loads (0-10lbs) and a very small percentage of time carrying loads weighing over 50lbs (1-2%). During their military service, Soldiers may be expected to carry extremely heavy loads for long distances over various types of terrain. [43,44] Current U.S. Army doctrine recommends that Soldiers carry no more than 48-72lbs (or 30-45% body weight) in the fighting load and approach march loads, respectively [45, 46]. Recruits at both training sites had some training in heavy loads providing further evidence that PA performed at each training site was similar.

Recruits from both training sites reported obtaining an average of about 6 hours of sleep each night on the daily PA log. Current US Army doctrine mandates that recruits be given the opportunity to receive 7 hours of continuous sleep each night while in garrison unless they are scheduled for a duty during the period [47]. The results of this study suggest that, although they may be allowed the full 7 hours, BCT recruits at both training sites report getting slightly less than the recommended amount of sleep. Although lights are turned off, recruits are not mandated to be in bed when this occurs and may complete some tasks after lights out. The self-reported sleep duration in this study is slightly greater than that of West Point cadets who reported receiving an average of 5 hours and 40 minutes of sleep per night during the 6 weeks of cadet basic training [47].

PRT is the physical training program mandated by TRADOC BCT doctrine. It consists of a variety of standardized exercises (such as preparatory drills, conditioning drills, movement drills, climbing drills, interval running, long distance running, and flexibility training), and is designed to progressively train Soldiers while reducing the risk of developing injuries.[2,18] Moderate and vigorous activity between 0500-0700 hours was examined to see if one of the major principles of PRT (progressive overload) was being followed. Moderate to vigorous activity tended to increase during the first 4 weeks of BCT at Ft Jackson. Although there was no significant difference in the weekly moderate to vigorous activity at Ft Sill, examination of the graph (Figure 2) does show a gradual increase, the slope of which was more gradual than at Ft Jackson. This suggests some increase in exercise intensity but perhaps not enough to be consistent with the progressive overload principle. After week 4 (Ft Jackson) or 7 (Ft Sill), the amount of time recruits spent in moderate to vigorous intensity PA from 0500 to 0700 hours at both training sites tended to decrease. This decrease could be related to increased time spent in military operations (road marching, basic rifle marksmanship, land navigation, field training exercises, etc.). When physically demanding activity was scheduled, physical training was reduced or not conducted at all in the early morning. The more physically demanding operational soldiering tasks are generally conducted later in training.

Over the course of the 8-weeks of BCT monitoring, the PAtracker indicated that the average daily percent time recruits spent engaging in calisthenics was not significantly different between the two training sites. The average percent daily time spent running differed slightly (1.2±1.7 vs. 1.6±2.0%, $p=0.04$). Calisthenics are unlikely to have been performed outside PRT. On the other hand, running could have been performed outside PRT but the large majority was likely performed during the PRT period. Although we cannot determine from these data if the specific drills of PRT were followed, it appears that the amount of time spent in these general activities was similar at the two sites.

Association between Physical Activity Measurement Methods

The findings in this study support the use of the ActiGraph as the instrument to measure PA intensity and the PAtracker and daily PA log to measure body position and PA type in the BCT environment. No single field measure of PA has proven valid, reliable, and logistically feasible over a wide range of population settings and uses [48].

Pearson product moment correlations are often used to interpret the degree of association between measurement tools, but not the agreement. A high correlation may suggest a strong association but does not imply close agreement between instruments because of the possibility of systematic bias [40, 41]. In this study, weak but positive correlations were noted when comparing the ActiGraph and PAtracker for measures of PA intensity, and the PA tracker and daily PA log for measures of body position and type of PA. These findings suggest that the measurement instruments were at least quantifying the intensity of PA, body position, and type of PA in a similar direction. The lower correlation suggest little agreement between the two methods, however, the correlations provided no definitive conclusions regarding the agreement between the measurement instruments for PA intensity, body position, and type of PA.

The LoA method as proposed by Bland and Altman [40] was used to assess agreement between the ActiGraph accelerometer and PAtracker for measures of PA intensity, and between the PAtracker and daily PA log for measures of body position and type of PA. How far apart the measurements can be without causing difficulties depends on the interpretation of method comparison and the sample size [40,41]. The resulting 95% LoA indicates that for the measure of intensity, the random error increased as the average daily minutes spent in each intensity increased. More specifically, there was disagreement between the ActiGraph and the PAtracker for all categories of intensity (See Figures 7 and 8). The accelerometer provides an objective measure of movement including intensity and has been used as a criterion measure in studies validating other PA instruments, such as the self-report instruments [49]. The PAtracker also provides a subjective measure of intensity through direct observation. However, correctly categorizing PA intensity through direct observation may be highly dependent on the training and experience of the observer and the environment in which the PA is occurring. The PAtracker underreported for all categories of intensity except light, which was over reported. In this study, the ActiGraph accelerometer, which has been validated in previous studies [33, 35], provided a better measure of PA intensity compared to the PAtracker.

Disagreement was also observed between the PAtracker and daily PA log for both PA type and body position for some categories. The difference between the observer's perception and a recruit's recollection of time spent in various body positions and types of PA may have contributed to the lack of agreement between these 2 measurement instruments. The differences between interpretations of operational definitions by an observer and a recruit may have also contributed to the disagreement. When compared with other PA studies that used one instrument alone, such as a pedometer for step counts or an accelerometer for intensity, the combined use of the PAtracker and daily PA log added to the characterization of PA in the BCT environment [48,49]. The use of both of these measurement instruments provided greater detail regarding the amount of time a recruit spent in different body positions and PA types, possible contributing factors in the incidence of musculoskeletal injuries during BCT.

A careful overview of the strengths and limitations of all available techniques is essential before an appropriate assessment method for a specific research question is chosen [50]. The method of choice for any environment should be accurate, precise, objective, simple to use, robust, time-efficient, cause minimal intrusion into habitual activity patterns, be socially acceptable, allow continuous and detailed recording of usual activity patterns, and be applicable to large population groups [51]. In this study, the ActiGraph accelerometer provided the best

measure of a recruit's PA intensity while the PAtracker and daily PA log were best at capturing body position and type of PA in the BCT environment.

Association between Injury and Physical Activity

The injury incidences were substantially higher at Ft Jackson than at Ft Sill. Depending on the injury index, injuries among the men were 1.27 to 1.45 times higher at Ft Jackson compared to Ft Sill. Among the women injuries were 1.48 to 1.80 higher at Ft Jackson compared to Ft Sill. When surveillance times were equated between the two locations, the average daily accelerometer counts differed little. This suggests that the average daily physical activity measured with accelerometers did not account for the differences in injury incidence between locations. Previous studies have shown that as the amount of physical activity increases, so does injury incidence. Studies have been conducted largely among runners [52-60] but also among athletic club members [61], military recruits [2,62-63] combinations of runners and walkers [64-67] and participants in sports and other leisure-time activity [68-70]. Most of these investigations have used self-reports of injuries and physical activity, although a few studies have documented injuries from medical records [62-63] and obtained physical activity from training logbooks [58,62,63].

Most relevant to the present investigation are previous studies at Ft Jackson that used Yamax pedometers to measure the amount of ambulatory activity in BCT [2,71]. In one of these investigations [2] 10 BCT companies were separated into three groups based on the number of steps/day. There were 3 companies in a "high" steps/day groups, 4 companies in a "moderate" steps/day group, and 3 companies in a "low" steps/day groups. The high steps/day group was at higher injury risk than groups that took fewer steps per day in a dose-response manner. The high activity group had 22% more steps/day than the low activity group [2]. In the current investigation there was only a 5% difference in the total accelerometer counts between locations despite the substantially higher injury risk at Ft Jackson compared to Ft Sill.

It might have been that factors other than physical activity accounted for the differences in injury risk between locations. Thus, an attempt was made to look at different levels of physical activity within each location separately. At each location separately, activity intensities were subcategorized by placing them into groups with high, moderate, and low activity. Even when this was done there was little consistent relationship between the subcategories and injury risk for any activity intensity.

Methodological differences between the present study and the previous study [2] should be considered. The previous study [2] used pedometers to measure ambulatory activity as the number of steps. The current investigation used accelerometers which accumulates "counts". Counts represent the magnitude of accelerations during bodily movements and take into account the intensity of the movement as well as the movement itself. More counts are recorded for a more vigorous movement (e.g., running) and fewer counts for a slower movement (e.g., walking). A pedometer cannot determine how vigorous the movement is. Studies that have compared Actigraph triaxial accelerometers counts and Yamax pedometer steps have reported correlations of 0.86 [72], 0.67 [73] and 0.51 [74], accounting for 74%, 45%, and 26% of the variance between the instruments. Thus, the instruments appear to be measuring some different aspects of

physical activity. It is possible that in BCT, the accumulated number of steps/day is a more important factor in injury risk than the count output of accelerometers.

Besides the difference in the measurement tools, the length of the daily surveillance time differed between the pedometer study [2] and the present one. In the pedometer study, steps during the entire day were measured. Pedometers were exchanged during the first morning formation but the recruits were required to wear the pedometer at all times except when showering or while in bed. This included Sundays and holidays. In the present investigation the accelerometers were only worn from the first morning formation to the evening meal, generally 12-13 hours/day. This time should have included the most active time of the day but any activities performed after the evening meal or before the first formation were not recorded. It is possible that the activities performed in the non-surveilled periods might have been important for injury risk.

Beside the daily surveillance time, the total number of surveillance days differed between the pedometer study [2] and the present one. In the pedometer study, the surveillance began on the third day of BCT and continued through graduation day. This covered 97% of the BCT period. In the present study, the truncated accelerator data comprised 44 days. The total BCT days were 69 at Ft Jackson and 67 at Ft Sill. Thus, the 44 days represented 64% of the total Ft Jackson days and 66% of the total days at Ft Sill. It is possible that the days that were not covered might have included important activity associated with injury risk.

Examining the total surveillance time (daily surveillance time and surveillance over days) provides a more comprehensive picture of the BCT surveillance time in the present study. Recruits were active for an estimated 18 hours each day (i.e., self-reported sleep time was about 6 hours). Thus, the estimated total time recruits were active was 1,242 hours at Ft Jackson (69 days X 18 hours/day) and 1,206 hours at Ft Sill (67 days X 18 hours/day). The actual average time that recruits were surveilled at Ft Jackson averaged 12.7 hours/day for 44 days (559 hours) while at Ft Sill it was 11.6 hours/day for 44 days (510 hours). Thus the total surveillance time in the truncated data represented 45% of the total active time at Ft Jackson (559/1,242) and 45% of the total time at Ft Sill (510/1,139). Even if the total (not truncated) days of surveillance were considered (50 days at Ft Jackson and 46 at Ft Sill), this represented 51% of the total time at Ft Jackson (635/1,242) and 47% at Ft Sill (534/1,139).

Study Strengths and Limitations

This study was limited by the fact that recruits were only observed during the middle 8-weeks of training as opposed to the entire 10 weeks. Eliminated were the first week of BCT, which consists mostly of classroom training and the final week, consisting primarily of cleaning equipment, taking care of paperwork and preparing for graduation. We also did not monitor the evening activities of the recruits (i.e., after the evening meal, generally after 1800 hours). Thus we missed some of the activities performed by recruits.

Due to limited personnel and resources, we were unable to instrument and observe all recruits in each training company. Therefore, the PA performed by the 24 recruits per company instrumented with an accelerometer and the one recruit per company who was followed and

observed using the PAtracker, was assumed to be representative of the PA performed by all recruits in each respective company.

If a recruit wearing an accelerometer or being observed using the PAtracker was sick, injured, or not training with their company for any reason that day they were immediately replaced with another consented volunteer. A limitation to this process was, due to study design, the number of times recruits had to be replaced was not tracked. However, since recruits were immediately replaced, the appropriate number of accelerometers was always distributed and one recruit per company was observed. Therefore, data was never lost due to attrition.

This study also used multiple methods of measuring PA, including accelerometry, direct observation and self-report questionnaires, which allowed study investigators to capture a complete representation of the PA performed during BCT.

CONCLUSIONS

The Army Surgeon General's Performance Triad initiative seeks to improve Soldier readiness and resilience by improving Soldiers' PA, sleep, and nutritional health behaviors. The ability to assess the quantity as well as the quality of current PA demands and recovery from PA are necessary to ensure Soldier safety along with optimal health and performance.

In terms of recovery, these data suggest, during BCT, recruits are receiving slightly less sleep than the recommended 7-8 hours per night, despite being allotted 7 hours each night to devote to sleep. This lack of rest and recovery during BCT may have an impact on a recruit's ability to perform their job sufficiently and maintain adequate health and resiliency.

This study primarily examined the PA aspect of the Performance Triad. This is the first study to quantify the amount, type, and intensity of PA demands during BCT. Physical activity is an important variable to support health and improve performance. It appears recruits are meeting the minimum PA recommendations for healthy adults put forth by the American College of Sports Medicine [75]. It is important to document the physical demands of the training program followed during BCT in order to ensure that the activities performed are sufficient to develop the physical fitness and performance of the Soldier, while not so excessive that the demands lead to the development of musculoskeletal injuries, a key barrier to individual and unit readiness. Data from this study revealed the average daily amount of PA and PRT performed by recruits, as measured with accelerometers, is similar across BCT sites. This finding suggests that PA alone does not account for the differences in injury incidence between locations.

The findings of this study suggest that in order to understand the current demands of PA in BCT, it is necessary to use a combination of self-report, direct observation, and electronic motion detection measurement instruments. Findings with regard to injury were not consistent with a previous study showing that as the numbers of steps per day increased so did the injury rate. Differences in the measuring instruments (accelerometer vs. pedometer) or in the number of days over which the surveillance was conducted may partly account for the differences

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Appendix A. Injury Risk Factor Survey Administered to Soldiers on Entry at Basic Combat Training

Physical Activity in Basic Combat Taining (2011): New Soldier Survey

Authority:	32 CFR 219, AR 70-25, and EO 9397
Principle Purpose:	Social Security Number (SSN) and name will be used to obtain information about your medical visits and injuries and Army Physical Fitness Test scores from Defense database systems.
Routine Uses:	The SSN and home address will be used for identification purposes and for research and evaluation only. Information derived from the study will be not be used outside of the Department of Defense.
Disclosure:	The furnishing of your name and SSN is required. Failure to provide the information may disqualify you from participating in this research study.

PLEASE READ ALL DIRECTIONS AND QUESTIONS CAREFULLY.

- Answer all questions to the best of your recollection.
- Ask research staff for help if you need it.
- Fill numbers in the boxes below, then fill in the corresponding bubbles.

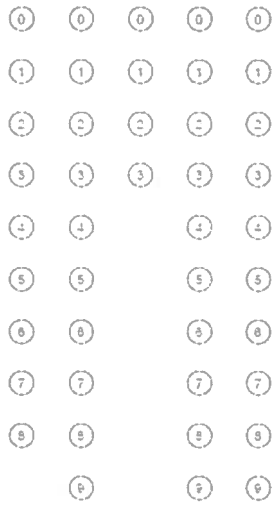
Social Security Number										
			-			-				

What is your name? (last name, first name, middle initial)

ABOUT YOU

1. Subject #			

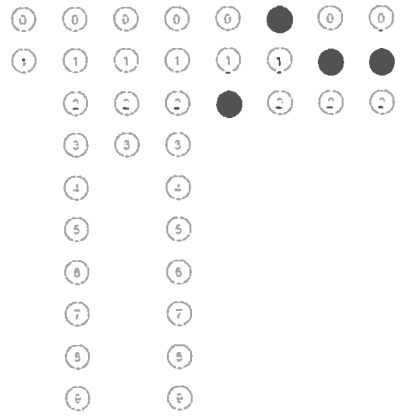
2.Height inches		3. Weight pounds		



ABOUT YOU

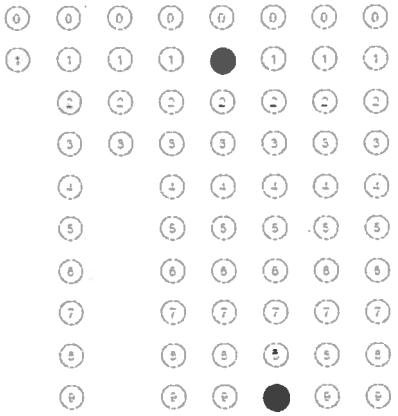
4. Today's Date

Month		Day		Year			
				2	0	1	1



5. Your Birth Date

Month		Day		Year			
				1	9		



6. Gender

Are you male or female? (M) (F)

TOBACCO USE

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

Yes (Y)

No (N)

8. How old were you when you smoked a whole cigarette for the first time? **(If you have never smoked a whole cigarette, write 00 and mark 00 in the bubbles provided below)**

		Years Old

(0) (0)
(1) (1)
(2) (2)
(3) (3)
(4) (4)
(5)
(6)
(7)
(8)
(9)

9. During the past 30 days, how many days did you smoke a cigarette? **(If you never smoked or not smoked in the last 30 days, write 00 and mark 00 in the bubbles provided below)**

		Days

(0) (0)
(1) (1)
(2) (2)
(3) (3)
(4)
(5)
(6)
(7)
(8)
(9)

10. During the past 30 days, how many cigarettes did you smoke per day? **(If you never smoked or not smoked in the last 30 days, write 00 and mark 00 in the bubbles provided below)**

		Cigarettes

(0) (0)
(1) (1)
(2) (2)
(3) (3)
(4) (4)
(5) (5)
(6) (6)
(7) (7)
(8) (8)
(9) (9)

11. If you used to smoke cigarettes and quit, how many months ago did you quit? **(If you never smoked or are a current smoker, write 00 and mark 00 in the bubbles provided below)**

		Months

(0) (0)
(1) (1)
(2) (2)
(3) (3)
(4) (4)
(5) (5)
(6) (6)
(7) (7)
(8) (8)
(9) (9)

PHYSICAL ACTIVITY

12. 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?

- ○ Much less active
- ○ Somewhat less active
- ○ About the same
- ○ Somewhat more active
- ○ Much more active

13. Over the last 2 months, what was the average number of time per week you exercised or played sports for at least 30 minutes at a time?

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

14. Over the last 2 months, how many times per week did you run or jog?

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

15. How long were you running or jogging before you entered basic training?

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

16. Over the last 2 months, how many times per week did you perform weight training exercises?

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

17. If you performed weight training in the last 2 months, how long have you been doing this?

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

INJURY HISTORY

18. Have you ever injured bone, muscle, tendon, ligaments, and/or cartilage in one or both of your lower limbs, ankles, or feet?

- (Y) Yes
- (N) No

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

- ○ Does not apply, never been injured
- (Y) Yes
- (N) No

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

- ○ Does not apply, never been injured
- (Y) Yes
- (N) No

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

If you are a woman, complete questions 20 through 25 on the following page.

WOMEN ONLY: MENSTRUAL HISTORY

21. At what age did you start to menstruate? **(If you have not had a menstrual cycle, write 00 and mark 00 in the bubbles provided below)**

		Years Old

(0) (0)
(1) (1)
(2) (2)
(3) (3)
(4) (4)
(5)
(6)
(7)
(8)
(9)

22. Over the last 12 months, how many menstrual periods did you have? **(If you have not had a menstrual period, write 00 and mark 00 in the bubbles provided below)**

		Menstrual Periods

(0) (0)
(1) (1)
(2) (2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)

23. During the last 12 months, have you ever missed six or more <u>months in a row</u> between menstrual cycles?

- ◯ I have never had a menstrual period
- (N) No, I have never missed 6 or more months in a row between menstrual cycles
- (Y) Yes, I have missed 6 or more months in a row between menstrual cycles.

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

- (Y) Yes
- (N) No

25. If you have ever been pregnant, how long (years and months) ago were you last pregnant **(If you have never been pregnant, write 00 and mark 00 in the bubbles provided below)**

		Years			Months

0	0	0	0
1	1	1	1
2	2		2
	3		3
	4		4
	5		5
	6		6
	7		7
	8		8
	9		9

Stop here and wait for further instructions. Thank you!

Question # 26 & 27 below to be filled out by Research Staff ONLY.

26.Height inches		27. Weight pounds		

0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4		4	4
5	5		5	5
6	6		6	6
7	7		7	7
8	8		8	8
	9		9	9

Appendix B. Manual Developed by USARIEM Physical Activity Subject Matter Experts and used to Train PAtracker Observers

Basic Combat Training

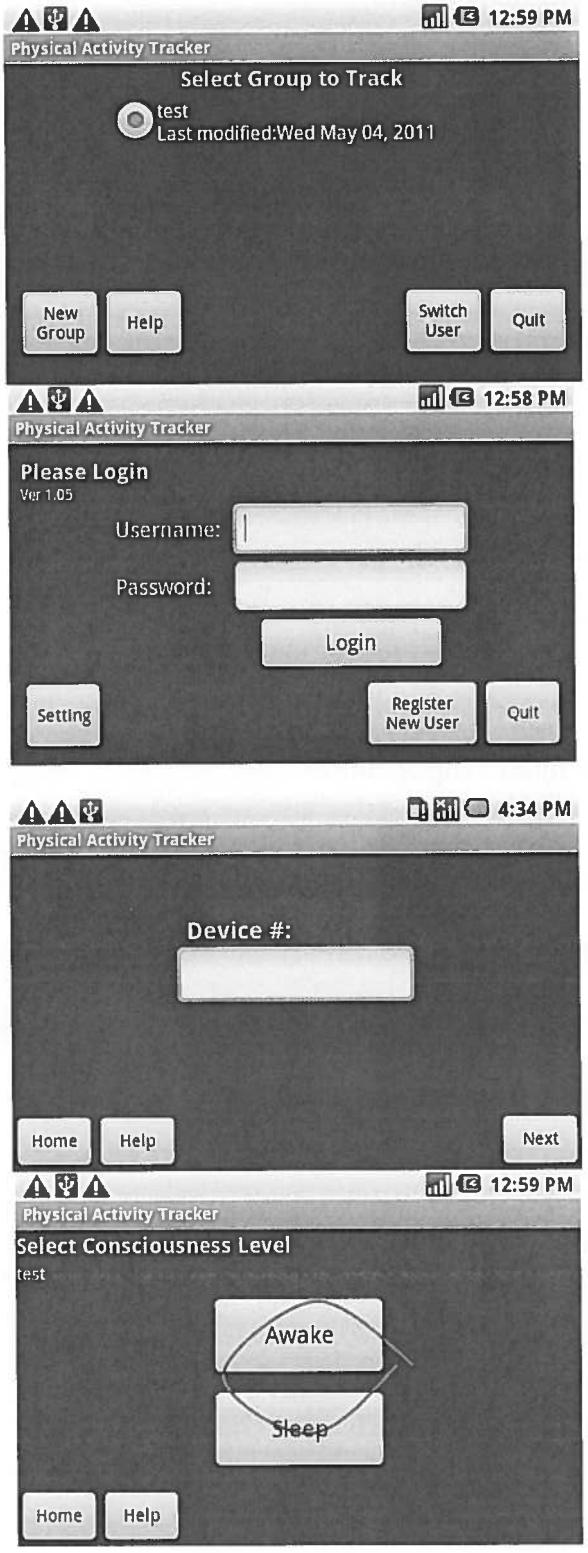
Physical Activity Observational Monitoring

Operational Definitions & Cataloguing/Classifying Physical Activity

Rules of Engagement:

1. Is the soldier awake or asleep?
2. What position is the soldier engaged in?
    - Lying, sitting, standing/on feet, or kneeling.
3. What activity is the soldier engaged in?
    - Stationary, walking, running, cadence marching, crawling, menial tasks, lifting/carrying, climbing/obstacles, calisthenics, or combatives.
4. What is the intensity (effort) of the activity the soldier is engaged in?
    - Resting, light, moderate, high, or maximum based on a 0-100 range
5. What load (pounds carried/lifted) is the soldier engaged in?
    - 0-10, 11-25, 26-50, 51-75,>75 lbs.
6. Only include activities that last 10 seconds or longer.

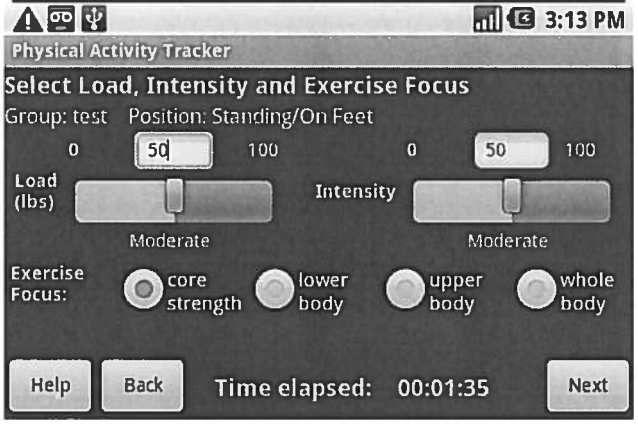
PA Tracker Logic Flow Matrix

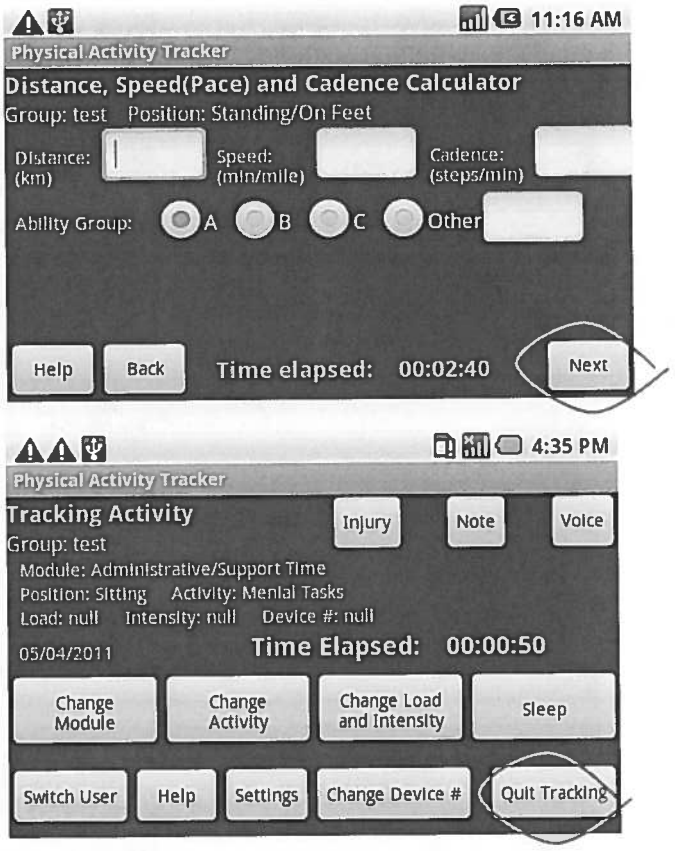



12:59 PM
Physical Activity Tracker
Select Module
Group: test
None
Administrati ve/Support
Basic Tactical
Drill and Ceremonies
Field Training
First Aid and
Guard Duty
Land Navigation
Mine, Countermin
Military Communica
Move Under
CBRN Defense
Help
Back
Time elapsed: 00:00:06


3:11 PM
Physical Activity Tracker
Select Position of Activity
Group: test
Lying
Sitting
Standing/ On Feet
Kneeling
Help
Back
Time elapsed: 00:00:10


1:04 PM
Physical Activity Tracker
Select Activity being Performed
Group: test Position: Standing/On Feet
Stationary
Walk
Run
Cadence March
Obstacle/ climbing
Menial Tasks
lifting/ carrying
Calisthenics
Combatives
Help
Back
Time elapsed: 00:00:24


3:13 PM
Physical Activity Tracker
Select Load, Intensity and Exercise Focus
Group: test Position: Standing/On Feet
0
50
100
0
50
100
Load (lbs)
Intensity
Moderate
Moderate
Exercise Focus:
core strength
lower body
upper body
whole body
Help
Back
Time elapsed: 00:01:35
Next



Choose ***Quit Tracking*** to EXIT

I. **Consciousness level:** Awake vs. Asleep

a. **Awake:** The natural conscious state where both mind and body are brought into awareness, alertness, arousal and activity, after having been asleep.

b. **Asleep:** A natural periodic state of rest, in which the eyes usually close and consciousness is completely or partially lost, so that there is a decrease in bodily movement and responsiveness to external stimuli.

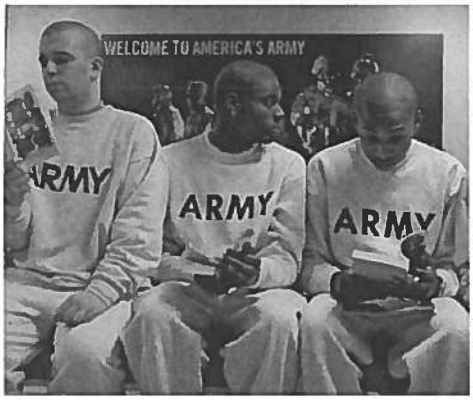
II. **Position During Activity:** Orientation of the body in regards to the horizon

i. **Lying:** Occurs when the body is more or less horizontal and supported along its length by the surface underneath. A soldier can lie with the front of their body downward, with their face up and the back of their body downward, or on their side (as in the fetal position).

Examples: Can occur during marksmanship training, during PT, or while the soldier is resting.

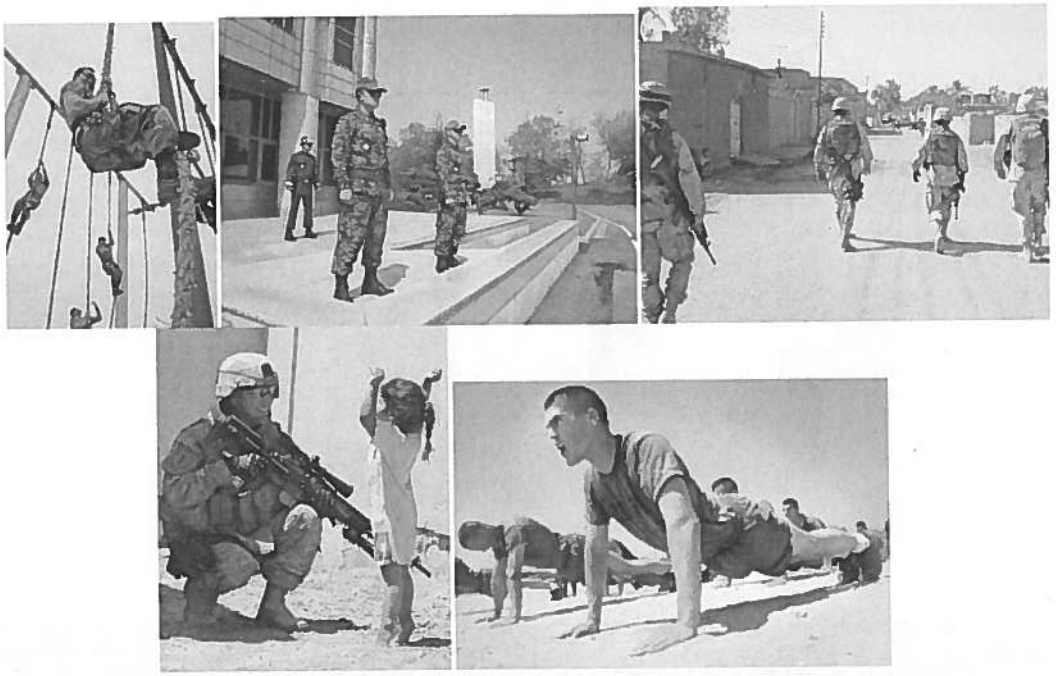
ii. **Sitting:** Occurs when the buttocks (gluteal/hips) and/or hamstrings come in contact with another structure/surface for support, while the torso is more or less upright. Sitting can occur with the knees unbent (legs horizontal and fully extended out in front of the body, often while on the ground or floor) or bent (in a chair or on an object, including the ground or floor; parallel or cross legged).

Examples: Sitting may occur while eating, during classroom instruction, while awaiting orders, etc.



iii. **Standing/On feet**: Occurs when the body is held upright and supported only by the feet. Body weight can be equally distributed or placed on one leg, or individuals may lean against an object. Standing at attention is a military standing posture, as is standing at ease. **Squatting** is considered standing as long as the hips and knees are not touching the ground.

Examples: During BCT, standing may occur while waiting in line, waiting for orders/assignment/instruction, or preparing for mobility. Pushups, climbing a rope or monkey bars are also considered to be the Standing/On Feet.



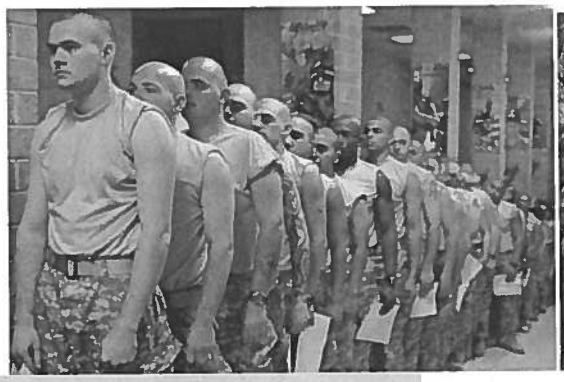
iv. **Kneeling:** Is the body position in which you rest on one or both knees. While kneeling, the torso is upright.

Examples: During BCT, kneeling may occur while conducting marksmanship training, performing menial tasks or resting.

1. Individuals may kneel on one knee or shin
2. Individuals may kneel on both knees or shins

III. **Physical Activity:** Physical activity is any bodily movement produced by skeletal muscles that result in an expenditure of energy.

a. **Stationary:** Not moving (fixed in position, immobile, motionless, static, or at rest). Examples: During BCT, soldiers can be stationary during classroom instruction or while eating, standing in line, standing at attention, resting, sitting, and lying down.



b. **Walking:** Method of locomotion. Walking occurs when one foot is continuously placed in front of the other to produce movement. Walking is typically slower than running and only **one** foot at a time leaves contact with the ground.

Examples: During BCT, walking can occur as transportation to mess, to the range, in formation, to class, and during instruction.

c. **Running:** Running differs from walking in that it is faster than walking and at some point during the running cycle **both** feet are off the ground at the same time.

Examples: During BCT, running occurs during the APFT, group runs, obstacle courses, 30-meter rushes, and tactical movements.

d. **Cadence Marching:** Type of locomotion in which soldiers march in step in formation as a unit and may or may not include a cadence call.

Examples: Tactical Foot March, Drill (marching), 5 km Foot March, 8 km Foot March, 10 km Foot March– with and without loads.

e. **Crawling:** A mode of locomotion in which an individual is on their hands and knees or dragging their body. Crawling can either be high or low, but will always be considered conducted in the lying position.

i. High Crawl: Body free of ground, weight of body resting on forearms and lower legs. Rifle cradled in arms, muzzle clear of the dirt. Move by alternately advancing elbows and knees.

ii. Low Crawl: Body flat as possible on the ground, cheek flat against ground. If carrying a rifle, it is dragged with thumb covering the muzzle. Push arms forward and cock one leg forward, then pull with forearms and push with leg. **Low crawling is of a higher intensity than high crawling.**

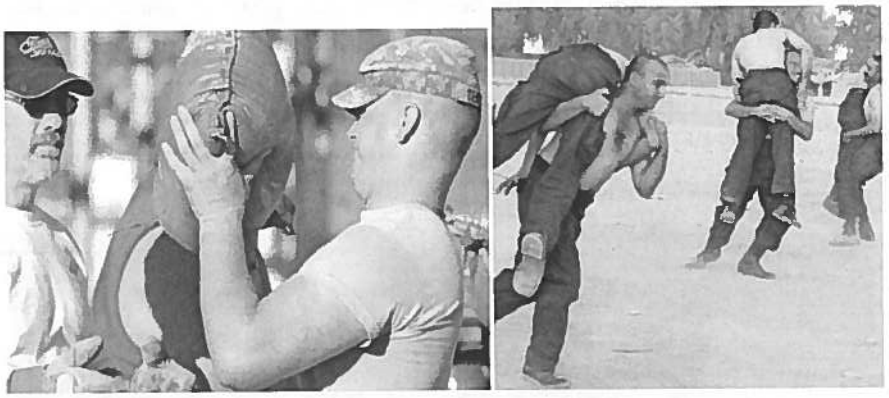
Examples: Tactical movement with, or without weapons or loads.

f. **Menial Tasks:** Menial tasks involve work not having, showing, or requiring special skill or proficiency.

Examples: During BCT, menial tasks include activities such as barracks upkeep, weapon cleaning, chores, and eating.

g. **Lifting and Carrying:** Lifting and carrying is defined as lifting an object, supporting that object with your hands and arms, and carrying the object a certain distance. The main goal of these activities is to move objects from point A to B.

Examples: During BCT, lifting and carrying can occur while lifting/carrying boxes of munitions, sandbags or crates of food, or during rescue carries.



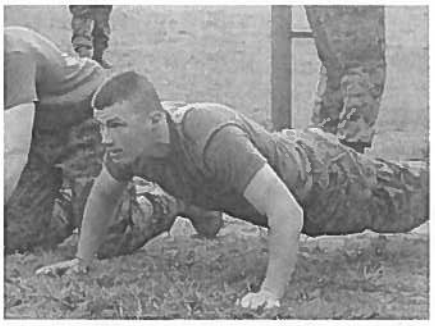
h. **Climbing/Obstacles:** Climbing occurs when an individual uses their hands and feet to ascend or move across an object. Obstacles involve completing a series of challenging physical obstacles, usually while being timed. Obstacles typically involve running, climbing, jumping, crawling and balancing elements.

Examples: During basic training, climbing may occur while climbing up a rope or across monkey bars. Obstacles will occur during BCT during obstacle courses.

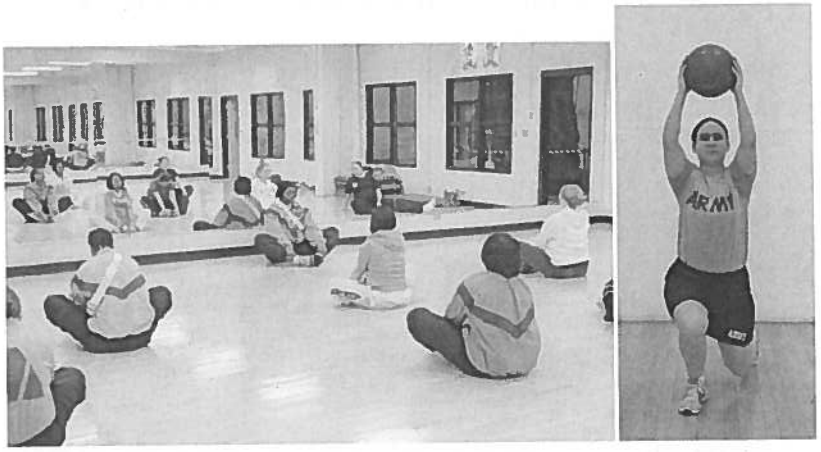
i. **Calisthenics:** Calisthenics are a form of organized exercise consisting of a variety of simple movements, performed with or without weights, which are intended to increase body strength and flexibility. They are usually conducted in concert with stretches and may precede a group run. Examples: APFT (sit-ups, push-ups), Calisthenics and stretching. Calisthenics will be placed into three subcategories:

   i. **Core:** exercises that primarily work the abdominal and lower back regions: BENT-LEG RAISE, SIDE BRIDGE, BACK BRIDGE, QUADRAPLEX, ROWER, PRONE ROW , WINDMILL, BENT-LEG BODY TWIST, V-UP, LEG-TUCK AND TWIST, SINGLE-LEG OVER, SUPINE BICYCLE, SWIMMER, CRUNCHES, SIT-UPS, HEEL HOOK, LEG TUCK, "I" "T" "Y" "W" "L" RAISES, SIDE-TO-SIDE KNEE LIFTS

   ii. **Upper:** exercises that primarily work the shoulder girdle: PUSH-UP, SINGLE-LEG PUSH-UP, OVERHEAD ARM PULL, STRAIGHT-ARM PULL, FLEXED-ARM HANG, ALTERNATING GRIP PULL-UP



iii. **Lower:** exercises that primarily work the hip girdle: REAR LUNGE, HIGH JUMPER, SQUAT BENDER, FORWARD LUNGE, THIGH STRETCH, TURN AND LUNGE, "Y" SQUAT, SINGLE-LEG DEAD LIFT, FRONT KICK ALTERNATE, TOE TOUCH, TUCK JUMP, STRADDLE-RUN FORWARD AND BACKWARD, HALF-SQUAT LATERALS, FROG JUMPS FORWARD AND BACKWARD, ALTERNATE ¼-TURN JUMP, ALTERNATE-STAGGERED SQUAT JUMP, LUNGE WALK, VERTICALS, LATERALS, SHUTTLE SPRINT, POWER SKIP, CROSSOVERS, CROUCH RUN, LATERAL LEG RAISE, MEDIAL LEG RAISE, BENT-LEG LATERAL RAISE, SINGLE-LEG TUCK, POWER JUMP



iv. **Whole Body:** exercises that work the entire body: JUMPING JACKS, BEND AND REACH, MOUNTAIN CLIMBER, EXTEND AND FLEX, HALF JACKS, SHOULDER ROLL, SOLDIER CARRY

j. **Combatives:** Includes hand-to-hand combat, similar to wrestling, between two or more people.

IV. **Intensity:** The amount/degree/magnitude of energy/force/effort transmitted during an activity by the subject being observed. **Do not compare to one's self**. First focus on soldier effort in terms of verbal anchoring (*rest, light, moderate, high, max*) and then the effort with the numerical percentage range:

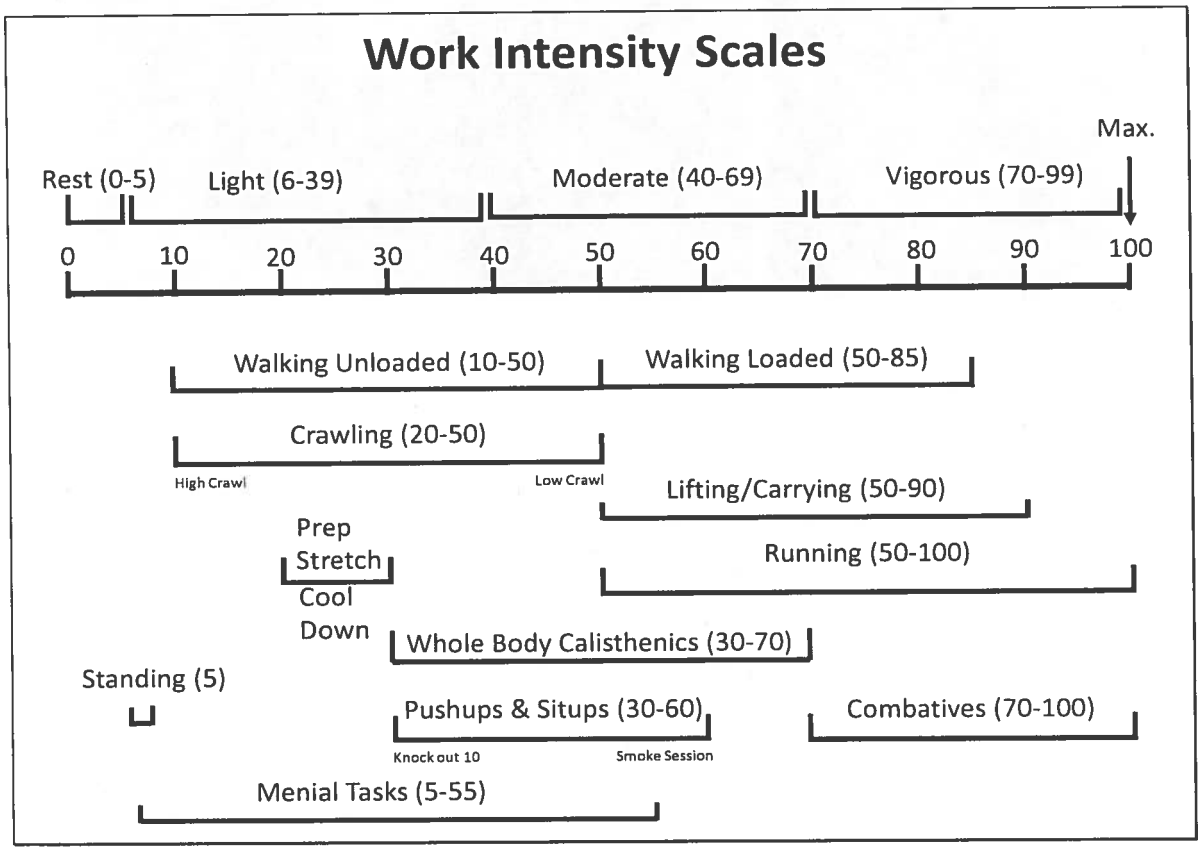
i. **Resting**, or 0-4% effort: asleep, sitting, lying with no work/motion being done, no effort/energy expended.

ii. **Light,** or 5-35% effort: Walking, slowly (stroll), Walking @2 mph - (30 min/mile), or stretching.

iii. **Moderate**, or 40-65% effort: Walking @ 15-20 min/mile pace - able to hold an out-loud conversation. Hiking up hills, Hiking hills with a 12 lb. pack, Calisthenics (push-ups, pull-ups, jumping jacks) or YOGA.

iv. **High,** or 70-95% effort: Jogging/running @ 12 - 6min/mile or combatives.

v. **Maximum**, or 96-100% effort: All-out effort, i.e. a sprint



V. Load

a. **Load:** The amount of weight that a person carries. This can be in the form of a back loaded cargo (backpack, rucksack, etc), and/or front loaded cargo (box, crate, sandbag, etc). It also includes a helmet worn or rifle carried.

i. 0-10 lbs.

ii. 11-25 lbs.

iii. 26-50 lbs.

iv. **51-75 lbs.**

v. **>75 lbs.**

Soldier Standard Loads	
Helmet, Rifle, Body Armor	**25 lbs.**
Helmet, Rifle, Body Armor, and a small Rucksack	**50 lbs.**
Helmet, Rifle, Body Armor, and large Rucksack	**75 lbs.**

VI. Suggested Cataloging of Common BCT PA using Current PAtracker Menu Options:

a. Eating Breakfast/Lunch/Dinner: SITTING – MENIAL TASK – LOAD (0-10) – INTENSITY (REST)

b. Walking to Mess Hall/Class: STANDING ON FEET – WALK - LOAD (0-10) – INTENSITY (LIGHT)

c. Marksmanship: LYING – MENIAL TASK - LOAD (0-10) – INTENSITY (LIGHT)

d. Cleaning Barracks: STANDING ON FEET– MENIAL TASK - LOAD (0-10) – INTENSITY (LIGHT)

e. Combatives: LYING – COMBATIVES - LOAD (0-10) – INTENSITY (HIGH)

f. Cadence March: STANDING ON FEET – CADENCE MARCH - LOAD (26-50) – INTENSITY (MODERATE)

g. PT Run on Trails: STANDING ON FEET – RUN – LOAD (0-10) – INTENSITY (HIGH)

h. In class/instruction: SITTING – STATIONARY - LOAD (0-10) – INTENSITY (RESTING

i. (Un)Loading Boxes from Truck: STANDING ON FEET – LIFTING/CARRYING - LOAD (51-75) – INTENSITY (HIGH)

j. Standing at Attention with Helmet & Rifle: STANDING ON FEET – STATIONARY - LOAD (11-25) – INTENSITY (LIGHT)

k. Jumping Jacks: STANDING – CALISTHENICS –WHOLE BODY (0-10) – INTENSITY (MODERATE)

l. Digging a Foxhole: STANDING ON FEET– MENIAL TASKS – LOAD (11-25) – INTENSITY (MODERATE)

m. Cleaning a Weapon – Gun: SITTING – MENIAL TASK - LOAD (0-10) – INTENSITY (LIGHT)

n. Crawling under Wire – LYING - CRAWLING - LOAD (11-25) - INTENSITY (MODERATE)

Observer Notes/Resources:

Foot Marches: Note proposed distance, proposed time, proposed load (listed under equipment)

Basic Combat Training Quick Reference (Foot Marches)

Type	Time	Standard	Equipment
FM 1 3KM	1 Hrs 15 Min	Complete the foot march with all assigned equipment, and as a member of assigned platoon.	During daylight, given a tactical scenario, assigned Weapon and equipment, Protective mask, empty field pack, and seasonal uniform.
FM 2 5KM	3 Hours	Complete the foot march with all assigned equipment, and as a member of assigned platoon.	an M16-Series rifle, assigned equipment, Protective Mask, a field pack, 10 rounds of blank ammunition, a seasonal uniform, and a total field pack load that does not exceed 15 lbs.
FM 3 8KM	3 hours	Complete the foot march with all assigned equipment, and as a member of assigned platoon.	an M16-series rifle, assigned equipment, a field pack, 10 rounds of blank ammunition, a seasonal uniform, and a total field pack load that does not exceed 25 lbs.
FM 4 10KM	3 hours	Complete the foot march with all assigned equipment, and as a member of assigned platoon.	During day or night, given a tactical scenario, an M16-Series rifle, assigned equipment, protective mask, a field pack, 10 rounds of blank ammunition, a seasonal uniform, and a total field pack load that does not exceed 35 lbs.
FM 5 10KM	Time in FTX 3 = 3.0 hrs	Complete the foot march with all assigned equipment, and as a member of assigned platoon.	During day or night, given a tactical scenario, an M16-Series rifle, assigned equipment, protective mask, a field pack, 10 rounds of blank ammunition, a seasonal uniform, and a total field pack load that does not exceed 35 lbs. or not to exceed 1/3 of the Soldiers Body weight
FM 6 15KM	Time in FTX 3 = 4.5 hrs	Complete the foot march with all assigned equipment, and as a member of assigned platoon.	During day or night, given a tactical scenario, an M16-Series rifle, assigned equipment, protective mask, a field pack, 10 rounds of blank ammunition, a seasonal uniform, and a total field pack load that does not exceed 35 lbs. or not to exceed 1/3 of the Soldiers Body weight

NOTE: *This is just a quick reference follow the actual Lesson Plan and Local commander Guidance*

805-B-2074

Appendix C. Daily Physical Activity Log Completed by Recruits at Ft Jackson

DIRECTIONS: Please write your last name and fill in your subject number. Fill in today's date and the number of hours/minutes you slept last night in the boxes below, then fill in the corresponding bubbles. Please indicate the time the device was put on and taken off your body in the boxes provided.

Last Name

Subject #			

Today's Date: MM/DD			

Hours Slept Last Night			
Hours		Minutes	

Daily Physical Activity Recording During Basic Combat Training

Instructions: Please indicate the physical activities you have participated in today as follows:

For example: if you sat for 5 and ½ hours today then:

Sitting			
Hours		Minutes	
0	5	3	0

Device Use

1. Did you wear the accelerometer all waking hours of the day? (Y) (N)
2. Did you train with your company the entire day? (Y) (N)

Device: (A) (B)

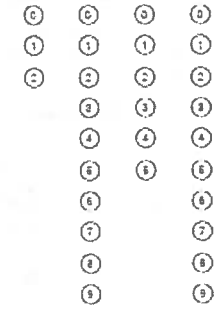
Time Device Placed On: (e.g., 6:00) _____ Time Device Taken Off: (e.g., 20.00)_____

3. If you did not train with your company all day, what did you do? (For example, KP, detail, medical, night guard, etc.)

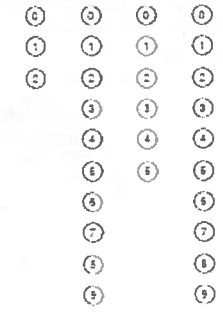
_____

Sitting	
Hours	Minutes

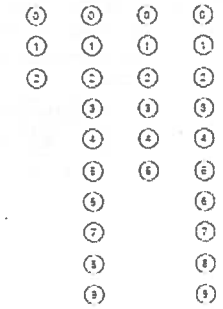
Standing/Formations	
Hours	Minutes



Walking/Marching	
Hours	Minutes



Running	
Hours	Minutes



Chores/Barracks Maintenance	
Hours	Minutes

Calisthenics/Obstacle & Confidence Courses	
Hours	Minutes

Carrying a Load/Pack	
Hours	Minutes

Load Carried
Pounds

Appendix D. Directions on how to complete the daily Physical Activity Log given to Ft Sill Recruits

DIRECTIONS:

-Write in your last name.

-Please fill in the requested boxes with numbers using the provided ink pen. Then, fill in the corresponding bubbles beneath them with the same pen. See example in the box on the right. ⟶

-Your subject number, Company, Platoon, and Today's date

-The number of hours/minutes you slept last night. This would also include time lying down without sleeping.

-Please indicate the time the activity device was put on and taken off your body today in the box provided. If not worn the entire day please indicate why in the space provided.

-On the second page of the activity log, the total time reported in the first four questions (time spent *sitting, standing, walking and running*) should equal the amount of time you reported wearing the activity device (device *on* minus device *off*) on the previous page.

-Time spent standing today. This would include the following activities: standing, waiting in line, and formation. Does not include walking, marching or running.

- The total time reported in the last four questions (time spent on *chores, calisthenics/obstacle, carrying pack, moderate-vigorous activity*) does not have to equal the amount of time you reported wearing the activity device.

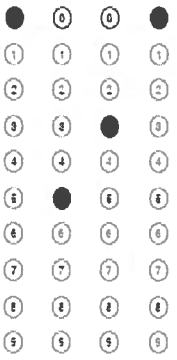
-Time spent in moderate to vigorous activity today. This would include activities that caused you to breathe much harder than normal, and/or break into a sweat. Examples would include: marching, running, obstacle course, calisthenics, combatives, lifting objects, and digging.

EXAMPLE:

Instructions: Please indicate the amount of time you were on your feet today. See Directions (box on the left) for examples of what qualifies as "on feet."

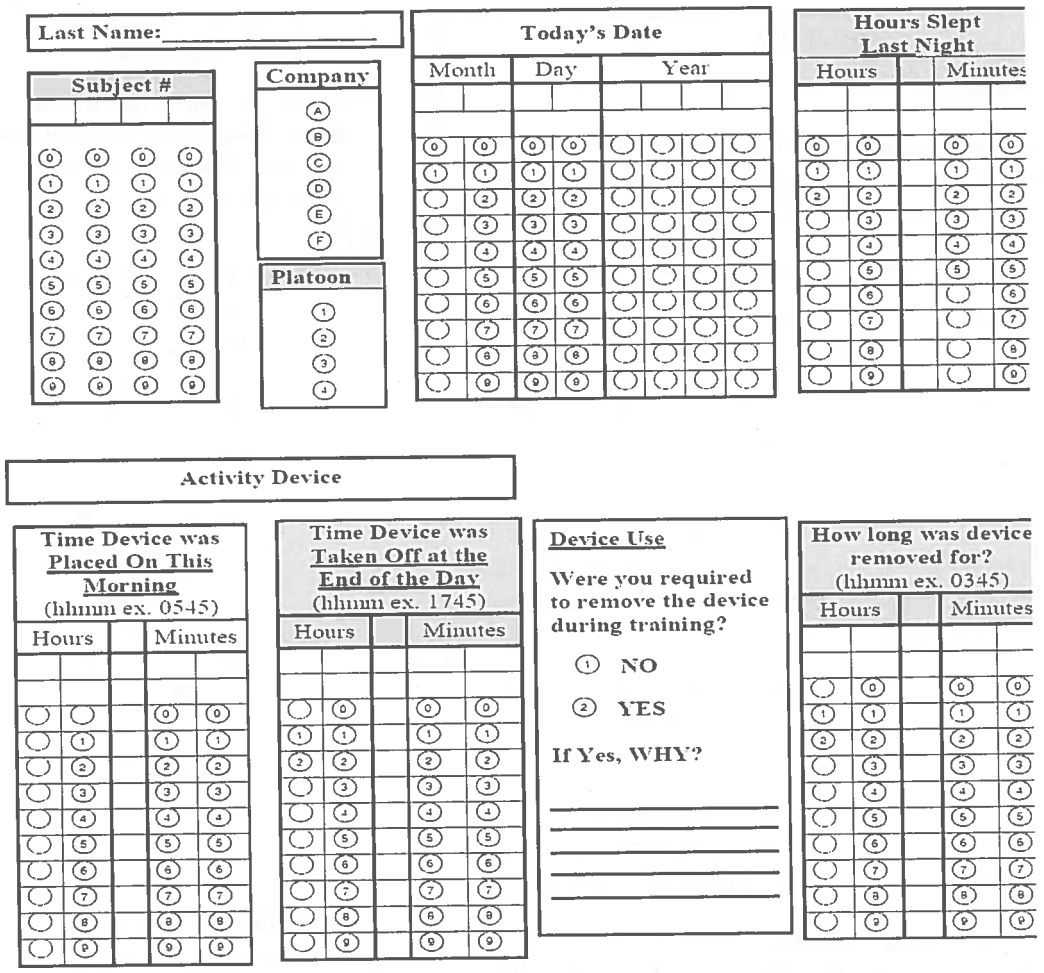
For example: if you were on your feet for 5 and ½ hours today then:

Time Spent on Feet Today			
Hours		Minutes	
0	5	3	0



To save time, the following methods of bubble shading are acceptable:

Appendix E. Daily Physical Activity Log Completed by Recruits at Ft Sill



1. Time Spent Sitting Today

Hours		Minutes	
0	0	0	0
1	1	1	1
2	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6		6
	7		7
	8		8
	9		9

2. Time Spent Standing Today

Hours		Minutes	
0	0	0	0
1	1	1	1
2	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6		6
	7		7
	8		8
	9		9

3. Time Spent Walking/Marching Today

Hours		Minutes	
0	0	0	0
1	1	1	1
2	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6		6
	7		7
	8		8
	9		9

4. Time Spent Running Today

Hours		Minutes	
0	0	0	0
1	1	1	1
2	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6		6
	7		7
	8		8
	9		9

---

5. Time Spent Doing Chores or Barracks Maintenance Today

Hours		Minutes	
0	0	0	0
1	1	1	1
2	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6		6
	7		7
	8		8
	9		9

6. Time Spent Doing Calisthenics/Obstacle Courses Today

Hours		Minutes	
0	0	0	0
1	1	1	1
2	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6		6
	7		7
	8		8
	9		9

7. Time Spent Carrying a Load Pack Today

Hours		Minutes	
0	0	0	0
1	1	1	1
2	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6		6
	7		7
	8		8
	9		9

8. Time Spent in Moderate-Vigorous Activity Today

Hours		Minutes	
0	0	0	0
1	1	1	1
2	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6		6
	7		7
	8		8
	9		9

Appendix F. Physical Activity Measured by Accelerometry for each Training Site by Company

Daily Percent Time (mean ± SD) Ft Jackson Recruits Spent in each Intensity Category by Training Company

	% Time Sedentary	% Time Light	% Time Moderate	% Time Vigorous
Alpha Company	60.4 ± 13.0	23.6 ± 12.4	12.5 ± 3.4 $^{\Omega}$	3.4 ± 2.7
Bravo Company	59.6 ± 12.3	23.3 ± 11.9	13.2 ± 3.8	4.0 ± 3.1
Charlie Company	60.1 ± 11.0	21.2 ± 10.3	14.4 ± 4.0$^{\epsilon}$	4.3 ± 3.8
Delta Company	56.9 ± 14.0	23.8 ± 12.8	15.0 ± 4.3*	4.4 ± 5.4§
Echo Company	60.7 ± 11.5	21.0 ± 10.3	12.8 ± 3.5	5.5 ± 4.1§
Foxtrot Company	59.0 ± 12.9	22.9 ± 11.9	14.0 ± 4.8	4.2 ± 3.4

$^{\Omega}$Different Charlie, Delta, and Foxtrot Companies, $p<0.05$
$^{\epsilon}$Different than Alpha and Echo Companies, $p<0.05$
*Different than Alpha and Echo Companies, $p<0.05$
§Different than Alpha and Bravo Companies, $p<0.05$

Daily Percent Time (mean ± SD) Ft Sill Recruits Spent in each Intensity Category by Training Company

	B1/79	D1/19	E1/19	E1/40	E1/79
Time Sedentary	64.9 ± 6.5$^{\epsilon}$	65.5 ± 5.8$^{\epsilon}$	64.0 ± 7.5*	69.7 ± 6.4*	64.9 ± 7.2*
Time Light	16.4 ± 3.3$^{\pounds}$	15.6 ± 3.0	16.5 ± 3.9$^{\alpha}$	14.6 ± 3.1	15.9 ± 3.8†
Time Moderate	12.9 ± 3.6*	11.9 ± 3.7*	14.1 ± 5.3*	10.3 ± 3.3†	12.2 ± 3.7†
Time Vigorous	5.8 ± 3.8$^{\Omega}$	7.1 ± 5.0*	5.4 ± 4.0$^{\Omega}$	5.4 ± 3.7$^{\Omega}$	6.9 ± 5.0*

*Different than all other companies, $p<0.05$
$^{\epsilon}$Different than E1/19, E1/40 and E1/79, $p<0.05$
†Different than B1/79, D1/19 and E1/19, $p<0.05$

Appendix G. Self-Reported Physical Activity of Ft Jackson Recruits by Training Company

Daily Time (mean mins ± SD) Recruits Self-Reported Physical Activity Log Category by Company at Ft Jackson

Company	Sleep	Sit	Stand	Walk	Run	Chores	Calisthenics	CarryLoad	Load	ModVig
Alpha Company	390.1 ±73.3$^{\alpha}$	342.0 ±127.9$^{\lozenge}$	119.6 ±79.5$^{\lozenge}$	93.3 ±61.7$^{\lozenge}$	29.5 ±34.2$^{\Pi}$	28.0 ±31.5$^{\Sigma}$	41.4 ±57.0$^{\alpha}$	67.1 ±101.4$^{\lozenge}$	11.9 ±15.6$^{\Omega}$	NA
Bravo Company	360.4 ±80.3$^{\alpha}$	308.2 ±138.7$^{\alpha}$	140.0 ±85.0$^{\Pi}$	128.0 ±84.6$^{\lozenge}$	28.1 ±30.5$^{\Pi}$	27.4 ±31.2$^{\Sigma}$	48.9 ±64.6$^{\Pi}$	146.1 ±121.6$^{\alpha}$	15.7 ±14.1$^{\Sigma}$	NA
Charlie Company	358.5 ±65.2$^{\alpha}$	288.1 ±114.3$^{\alpha}$	168.7 ±91.7$^{\lozenge}$	167.7 ±93.4$^{\lozenge}$	42.3 ±41.6$^{\lozenge}$	38.4 ±29.4$^{\Omega}$	71.2 ±71.3$^{\lozenge}$	138.7 ±124.6$^{\lozenge}$	17.6 ±15.1$^{\Sigma}$	NA
Delta Company	364.8 ±80.2$^{\alpha}$	283.2 ±130.2$^{\lozenge}$	155.8 ±94.9$^{\Pi}$	170.0 ±107.8 $^{\alpha}$	34.3 ±48.6$^{\Sigma}$	27.3 ±33.9$^{\Sigma}$	102.7 ±200.4$^{\Omega}$	170.7 ±235.7$^{\lozenge}$	16.3 ±18.6$^{\Sigma}$	NA
Echo Company	383.0 ±75.8$^{\lozenge}$	312.3 ±125.2$^{\lozenge}$	139.5 ±92.0$^{\lozenge}$	113.2 ±81.4$^{\lozenge}$	28.3 ±34.7$^{\Pi}$	29.2 ±41.6$^{\Pi}$	47.8 ±76.0$^{\alpha}$	73.3 ±109.6$^{\alpha}$	17.8 ±19.4$^{\Sigma}$	NA
Foxtrot Company	327.7 ±83.0$^{\Omega}$	232.5 ±125.5$^{\Omega}$	153.3 ±93.8$^{\alpha}$	164.6 ±95.2 $^{\alpha}$	38.9 ±55.1 $^{\alpha}$	22.4 ±46.8$^{\Pi}$	65.7 ±99.9$^{\alpha}$	94.2 ±141.5$^{\lozenge}$	15.5 ±17.0$^{\Sigma}$	NA
Jackson AVG	363.9 ±78.9	292.4 ±130.4	147.3 ±91.6	140.6 ±93.7	34.0 ±42.6	29.0 ±37.4	63.3 ±107.9	111.9 ±149.9	16.0 ±17.1	NA

$^{\Sigma}$ Different from one company, p<0.05, $^{\Pi}$Different from two companies, p<0.05, $^{\alpha}$Different from three companies, p<0.05, $^{\lozenge}$Different from four companies, p<0.05, $^{\Omega}$Different from all companies, p<0.05

Daily Percent Time (% ± SD), or Daily Time (mean mins ± SD) Recruits Self-Reported Physical Activity Log Category by Company at Ft Jackson

Company	Time Sedentary (mins)	% Sit	% Stand	% Walk	% Run	Time on Feet (mins)	% OnFeet	% Time Sedentary	% Time Sleep
Alpha Company	851.7 ±126.1$^{\Pi}$	58.8 ±20.5$^{\Omega}$	20.3 ±12.4$^{\Omega}$	16.0 ±9.9$^{\Omega}$	5.1 ±5.8$^{\Pi}$	242.5 ±133.9$^{\lozenge}$	41.2 ±20.5$^{\Omega}$	79.1 ±12.8$^{\lozenge}$	27.0 ±4.9$^{\lozenge}$
Bravo Company	808.6 ±143.5$^{\Pi}$	51.1 ±21.4$^{\lozenge}$	23.1 ±13.3$^{\Pi}$	21.8 ±13.5$^{\lozenge}$	4.7 ±4.9$^{\Pi}$	296.1 ±142.0$^{\lozenge}$	48.9 ±21.4$^{\lozenge}$	74.2 ±14.8$^{\lozenge}$	25.0 ±5.4$^{\alpha}$
Charlie Company	815.3 ±135.2$^{\Pi}$	43.9 ±17.1$^{\lozenge}$	25.0 ±12.4$^{\Sigma}$	24.7 ±12.3$^{\lozenge}$	6.4 ±6.2$^{\lozenge}$	378.6 ±148.4$^{\lozenge}$	56.1 ±17.1$^{\lozenge}$	69.0 ±13.8$^{\lozenge}$	24.9 ±4.4$^{\alpha}$
Delta Company	789.1 ±136.2$^{\Omega}$	44.8 ±20.1$^{\lozenge}$	24.0 ±13.1$^{\Sigma}$	26.1 ±15.0$^{\lozenge}$	5.2 ±6.1$^{\Pi}$	360.1 ±164.0$^{\alpha}$	55.2 ±20.1$^{\lozenge}$	69.9 ±16.2$^{\lozenge}$	25.6 ±5.1$^{\alpha}$
Echo Company	833.2 ±138.9$^{\Pi}$	52.7 ±18.2$^{\lozenge}$	23.2 ±12.6$^{\Pi}$	19.1 ±12.8$^{\lozenge}$	5.0 ±6.0$^{\Pi}$	280.9 ±128.0$^{\lozenge}$	47.4 ±18.2$^{\lozenge}$	76.0 ±14.6$^{\lozenge}$	26.7 ±4.6$^{\lozenge}$
Foxtrot Company	713.9 ±146.8$^{\Omega}$	39.8 ±19.4$^{\Omega}$	25.8 ±13.3$^{\alpha}$	27.9 ±15.0$^{\lozenge}$	6.6 ±7.2$^{\lozenge}$	356.8 ±149.3$^{\lozenge}$	60.3 ±19.4$^{\Omega}$	65.8 ±16.0$^{\Omega}$	23.0 ±5.1$^{\Omega}$
Jackson AVG	807.5 ±142.5	48.2 ±20.2	23.7 ±12.9	22.7 ±13.8	5.6 ±6.2	321.8 ±152.3	51.9 ±20.2	72.4 ±15.2	25.5 ±5.0

$^{\Sigma}$ Different from one company, p<0.05, $^{\Pi}$Different from two companies, p<0.05, $^{\alpha}$Different from three companies, p<0.05, $^{\lozenge}$Different from four companies, p<0.05, $^{\Omega}$Different from all companies, p<0.05

Appendix H. Self-Reported Physical Activity of Ft Sill Recruits by Training Company

Daily Time (mean mins ± SD) Recruits Self-Reported Physical Activity Log Category by Company at Ft Sill

Company	Sleep	Sit	Stand	Walk	Run	Chores	Calisthenics	CarryLoad	Load	ModVig
D119 Company	386.4 ±67.5$^{\Pi}$	268.1 ±120.0$^{\Pi}$	233.1 ±101.9$^{\Omega}$	115.7 ±78.1$^{\Sigma}$	46.2 ±41.6$^{\Sigma}$	22.5 ±21.1$^{\alpha}$	52.9 ±65.7$^{\Sigma}$	49.7 ±68.4$^{\alpha}$	NA	86.9 ±94.6$^{\Pi}$
E140 Company	372.3 ±69.8$^{\Pi}$	296.0 ±145.1$^{\Omega}$	222.7 ±111.8$^{\Pi}$	128.5 ±86.5$^{\Pi}$	37.5 ±37.0$^{\alpha}$	22.4 ±24.9$^{\alpha}$	49.8 ±60.6$^{\Sigma}$	46.7 ±57.7$^{\Sigma}$	NA	107.9 ±95.6$^{\Pi}$
B179 Company	385.0 ±67.6$^{\Pi}$	309.0 ±128.1$^{\Pi}$	183.0 ±93.2$^{\Pi}$	123.6 ±80.4$^{\Sigma}$	42.0 ±40.5$^{\Pi}$	32.9 ±26.4$^{\alpha}$	50.9 ±62.8$^{\alpha}$	62.1 ±79.2$^{\Sigma}$	NA	90.6 ±98.1$^{\alpha}$
E119 Company	383.9 ±65.4$^{\Omega}$	298.6 ±134.3$^{\Pi}$	229.0 ±99.7$^{\Pi}$	119.3 ±79.9$^{\Sigma}$	40.5 ±37.8$^{\Pi}$	33.9 ±35.1$^{\alpha}$	75.3 ±72.1$^{\Sigma}$	57.7 ±73.5$^{\Pi}$	NA	118.2 ±98.7$^{\alpha}$
E179 Company	355.8 ±53.5$^{\Omega}$	237.8 ±117.3$^{\Omega}$	259.9 ±98.9$^{\Omega}$	138.0 ±83.1$^{\alpha}$	32.3 ±35.3$^{\Pi}$	16.7 ±23.3$^{\Omega}$	57.3 ±61.7$^{\Sigma}$	49.4 ±74.2$^{\Sigma}$	NA	93.9 ±98.2$^{\Pi}$
Sill AVG	376.3 ±65.8	280.8 ±131.7	227.1 ±104.2	125.1 ±82.0	39.6 ±38.7	25.5 ±27.5	57.6 ±65.5	53.0 ±71.1	NA	99.7 ±97.7

$^{\Sigma}$ Different from one company, p<0.05, $^{\Pi}$Different from two companies, p<0.05, $^{\alpha}$Different from three companies, p<0.05, $^{\Diamond}$Different from four companies, p<0.05, $^{\Omega}$Different from all companies, p<0.05

Daily Percent Time (% ± SD), or Daily Time (mean mins ± SD) Recruits Self-Reported Physical Activity Log Category by Company at Ft Jackson

Company	Time Sedentary (mins)	% Sit	% Stand	% Walk	% Run	Time on Feet (mins)	% OnFeet	% Time Sedentary	% Time Sleep
D119 Company	501.2 ±107.9$^{\Pi}$	40.6 ±17.6$^{\Diamond}$	35.2 ±14.9$^{\Omega}$	17.2 ±10.5$^{\Sigma}$	7.0 ±6.3$^{\Sigma}$	395.0 ±136.1$^{\Omega}$	59.4 ±17.6$^{\Omega}$	75.9 ±13.1$^{\Sigma}$	26.8 ±4.5$^{\Pi}$
E140 Company	518.8 ±119.5$^{\Pi}$	43.3 ±20.2$^{\Diamond}$	32.6 ±16.1$^{\Omega}$	18.6 ±12.0$^{\Sigma}$	5.6 ±5.6$^{\alpha}$	388.8 ±151.9$^{\Sigma}$	56.7 ±20.2$^{\Omega}$	75.9 ±14.0	25.8 ±4.7$^{\Pi}$
B179 Company	492.1 ±115.2$^{\alpha}$	47.5 ±18.9$^{\alpha}$	27.6 ±12.9$^{\alpha}$	18.7 ±11.5$^{\Sigma}$	6.3 ±5.9$^{\Pi}$	348.6 ±147.6$^{\Pi}$	52.6 ±18.9$^{\alpha}$	75.1 ±13.5$^{\Pi}$	26.7 ±4.5$^{\Pi}$
E119 Company	527.3 ±117.8$^{\alpha}$	43.4 ±18.2$^{\alpha}$	33.4 ±14.0$^{\alpha}$	17.3 ±11.3$^{\Sigma}$	5.9 ±5.6$^{\Sigma}$	388.9 ±138.5$^{\Pi}$	56.7 ±18.2$^{\alpha}$	76.8 ±13.0	26.6 ±4.4$^{\Omega}$
E179 Company	497.8 ±116.4$^{\Pi}$	35.5 ±16.3$^{\Omega}$	39.1 ±14.1$^{\Omega}$	20.6 ±12.1$^{\alpha}$	4.8 ±5.3$^{\alpha}$	430.2 ±129.1$^{\Omega}$	64.5 ±16.3$^{\Omega}$	74.6 ±13.2$^{\Sigma}$	24.7 ±3.6$^{\Omega}$
Sill AVG	507.7 ±116.1	41.8 ±18.6	33.8 ±14.9	18.5 ±11.6	5.9 ±5.8	391.8 ±142.7	58.2 ±18.6	75.7 ±13.4	26.1 ±4.4

$^{\Sigma}$ Different from one company, p<0.05, $^{\Pi}$Different from two companies, p<0.05, $^{\alpha}$Different from three companies, p<0.05, $^{\Diamond}$Different from four companies, p<0.05, $^{\Omega}$Different from all companies, p<0.05

Appendix I. Training Company Run Information Measured by GPS

Data for runs by Company B1/79 at Ft Sill. Runs were along a road.

Date	Subject	Distance (miles)	Time (minutes)	Time / Mile (min/mile)
4 Aug	2026	1.35	13.20	9.80
	2030	1.84	15.93	8.65
	2037	2.43	20.63	8.48
	2045	1.40	13.15	9.37
6 Aug	2026	1.68	16.45	9.80
	2030	2.35	20.87	8.89
	2037	2.51	21.38	8.52
	2045	1.74	15.93	9.16
16 Aug	2026	2.02	18.83	9.31
	2030	1.95	16.45	8.43
	2037	1.93	15.80	8.19
	2045	1.66	15.78	9.50
24 Aug	2026	2.27	21.15	9.31
	2030	3.87	28.57	7.37
	2037	3.92	30.17	7.70
	2045	1.95	17.31	8.87
6 Sep	2026	2.53	22.68	8.95
	2030	3.76	26.87	7.14
	2037	3.83	29.1	7.59
	2045	2.56	21.83	8.53
13 Sep	2026	2.24	20.60	9.19
	2030	3.97	30.63	7.71
	2037	3.71	28.75	7.76
	2045	2.55	24.47	9.60

Data for runs by Company D1/19 at Ft Sill.

Date	Subject	Distance (miles)	Time (minutes)	Time / Mile (min/mile)
9 Aug	2100	1.97	20.97	10.6
	2106	1.99	17.69	8.89
	2112	1.99	16.95	8.52
	2118	1.94	16.49	8.50
11 Aug	2118	1.94	16.47	8.49
13 Aug	2100	2.65	21.67	8.17
	2106	2.65	21.62	8.15
	2112	2.66	21.67	8.15
	2118	2.26	17.6	7.78
15 Aug	2100	2.31	18.88	8.17
	2106	2.33	19.57	8.41

	2112	2.33	18.25	7.83
	2118	2.33	20.13	8.64
19 Aug	2100	2.65	22.68	8.57
	2106	2.83	22.47	7.95
	2112	2.91	21.6	7.43
	2118	1.85	16.27	8.80
23 Aug	2112	2.01	15.47	7.70
24 Aug	2100	2.02	16.55	8.20
26 Aug	2100	2.73	23.15	8.49
	2106	2.74	23.28	8.56
	2112	3.00	23.08	7.69
	2118	1.50	13.28	8.88
29 Aug	2100	3.02	23.53	7.79
	2106	3.32	28.30	8.52
	2112	3.18	26.42	8.30
	2118	3.29	28.23	8.59
2 Sep	2100	2.60	19.77	7.60
	2106	1.79	15.12	8.44
	2112	2.07	19.10	9.24
	2118	1.80	15.03	8.38
7 Sep	2106	1.98	14.12	7.13
9 Sep	2100	3.30	25.82	7.85
	2112	3.19	24.07	7.55
	2118	3.01	26.35	8.74
12 Sep	2112	3.47	28.32	8.16
	2118	2.57	25.25	9.77
19 Sep	2100	2.66	22.58	8.49
	2106	3.32	26.18	7.89
	2112	3.55	29.75	8.38
	2118	3.42	28.25	8.27
24 Sep	2118	1.99	13.52	6.81

Data for runs by Company E1/19 at Ft Sill. Runs were typically around the 1.0 mile course shown in Figure 8. Sometimes two laps were run.

Date	Subject	Distance (miles)	Time (minutes)	Time / Mile (min/mile)
2 Aug	2050	1.03	7.37	7.13
	2055	1.02	6.67	6.56
	2061	1.04	9.05	8.69
	2069	1.02	7.17	7.03
6 Aug	2050	2.59	23.46	9.06
	2055	2.59	28.85	11.1
8 Aug	2050	1.96	15.25	7.79
	2055	1.94	15.07	7.76
	2061	1.96	17.13	8.74
	2069	1.95	15.28	7.82
13 Aug	2050	1.98	14.75	7.45
	2055	1.99	13.73	6.92
	2061	2.03	18.43	9.08
	2069	1.97	15.32	7.78

15 Aug	2050	0.99	8.30	8.39
	2055	1.81	21.5	11.9
	2061	0.99	8.48	8.57
	2069	0.97	8.25	8.52
19 Aug	2050	1.95	15.08	7.75
	2055	1.94	14.07	7.23
	2061	1.96	15.67	7.99
	2069	1.95	15.58	7.98
23 Aug	2050	0.97	7.18	7.41
	2055	0.93	6.18	6.64
	2061	No data		
	2069	No data		
26 Aug	2050	1.82	14.50	7.96
	2055	1.82	13.33	7.56
	2061	0.84	6.60	7.84
	2069	1.95	16.37	8.41
29 Aug	2050	1.97	15.82	8.05
	2055	2.09	17.57	8.40
	2061	No data		
	2069	1.96	17.30	8.83
9 Sep	2050	2.04	16.12	7.90
	2055	2.01	14.2	7.04
	2061	No data		
	2069	No data		
13 Sep	2069	1.98	15.48	7.82
23 Sep	2050	2.04	17.73	8.70
	2055	2.06	17.63	8.86
	2061	No data		
	2069	2.03	16.28	8:03

Data for runs by Company E1/40 at Ft Sill. Runs were on loops around the buildings and along a road.

Date	Subject	Distance (miles)	Time (minutes)	Time / Mile (min/mile)
1 Aug	2017	1.00	7.75	7.75
2 Aug	2002	0.98	9.10	9.28
	2011	0.99	6.42	6.48
	2022	0.99	6.78	6.82
8 Aug	2002	1.17	11.87	10.1
	2011	1.99	15.60	7.85
	2017	1.44	11.98	8.32
	2022	1.53	12.22	8.01
15 Aug	2002	0.98	9.76	9.96
	2011	1.94	13.82	7.12
	2017	2.01	16.85	8.38
	2022	1.92	14.17	7.36
24 Aug	2002	3.34	26.67	7.99
	2017	1.89	15.39	8.14

	2022	2.12	21.37	10.1
27 Aug	2002	0.28	2.78	9.98
	2022	2.01	13.95	6.95
29 Aug	2002	3.60	38.13	10.6
	2017	3.87	35.60	9.21
	2022	5.59	46.55	8.33
31 Aug	2011	1.69	14.93	8.81
	2022	4.51	37.45	8.30
9 Sep	2002	1.91	20.67	10.8
	2017	3.77	29.37	7.79
	2022	3.57	28.55	8.00
19 Sep	2011	2.56	24.35	9.53
	2017	2.57	24.47	9.52

Data for runs by Company E1/79 at Ft Sill. Runs were primarily along a road.

Date	Subject	Distance (miles)	Time (minutes)	Time / Mile (min/mile)
6 Aug	2086	1.04	8.13	7.83
	2094	1.02	7.87	7.74
8 Aug	2084	1.50	10.85	7.25
	2086	1.55	13.05	8.43
	2094	1.56	13.02	8.36
15 Aug	2074	2.11	22.10	10.5
	2084	2.22	17.03	7.66
	2086	2.56	22.22	8.67
	2094	2.10	19.05	9.07
17 Aug	2086	5.16	43.50	8.43
22 Aug	2074	2.65	28.08	10.6
	2084	4.98	39.49	7.93
	2086	3.20	29.22	9.12
	2094	2.99	31.00	10.4
31 Aug	2084	3.08	22.15	7.19
	2086	3.03	31.07	10.3
6 Sep	2074	3.04	32.23	10.6
	2086	2.68	23.63	8.82
24 Sep	2094	2.04	22.40	11.0

Comparison of one- and two-mile runs with Actigraph data for Subject 2055 from Ft Sill Company E1/19. Comparisons were completed using Matlab.

Date	Run Distance (miles)	Actigraph Step Count
2 Aug	1	2358
8 Aug	2	4085
19 Aug	2	3624
23 Aug	1	2514
26 Aug	2	3670
29 Aug	2	2829
9 Sep	2	4310
23 Sep	2	No data

Running Summary Information for each Recruit Wearing a GPS at Fort Sill.

Company	Subject	Gender	Distance (miles)	Time (minutes)	Fastest Pace (mph)	Number of Runs
B1/79	2026	F	12.1	113	8.95	6
	2030	M	17.7	139	7.37	6
	2037	M	18.3	146	7.70	6
	2045	M	11.9	108	8.53	6
D1/19	2100	F	25.9	216	7.60	10
	2106	M	23.0	188	7.13	9
	2112	M	30.4	245	7.43	11
	2118	M	27.9	237	6.81	12
E1/19	2050	M	19.0	153	7.13	11
	2055	M	20.1	176	6.56	11
	2061	M	8.8	75	7.84	6
	2069	M	15.8	127	7.03	9
E1/40	2002	F	12.3	119	7.99	7
	2011	M	9.2	75	6.48	5
	2017	M	16.6	141	7.75	7
	2022	M	22.2	181	6.82	8
E1/79	2074	F	7.8	82	10.6	3
	2084	M	11.8	90	7.19	4
	2086	M	19.2	171	7.83	7
	2094	M	9.7	93	7.74	5

Total distances and times during runs from human motion detected from GPS data, Fort Sill.

Company	Subject	Total Distance (miles)	Total Time (hours)	Speed (miles/hr)
B1 79	2026	45.4	12.3	3.7
	2030	60.9	14.0	4.4
	2037	58.5	13.7	4.3
	2045	48.5	12.5	3.9
D1 19	2100	105	28.4	3.7
	2106	95.1	25.6	3.7
	2112	119	32.1	3.7
	2118	108	29.0	3.7
E1 19	2050	105	29.1	3.6
	2055	90.9	24.7	3.7
	2061	89.4	25.2	3.5
	2069	87.2	23.8	3.7
E1 40	2002	56.6	15.1	3.7
	2011	43.4	11.3	3.8
	2017	49.8	12.2	4.1
	2022	71.9	17.4	4.1
E1 79	2074	76.8	21.3	3.7
	2084	81.2	21.1	3.8
	2086	81.7	21.9	3.7
	2094	72.4	20.0	3.6