U.S. Army Center for Health Promotion and Preventive Medicine

USCHPPM

EPIDEMIOLOGICAL CONSULTATION REPORT NUMBER 29-HE-1395-00
DETERMINING PHYSICAL FITNESS CRITERIA
FOR ENTRY INTO ARMY BASIC COMBAT TRAINING:
CAN THESE CRITERIA BE BASED ON INJURY RISK?
FORT JACKSON, SOUTH CAROLINA
1998

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U.S. Army Center for Health Promotion and Preventive Medicine

The lineage of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) can be traced back over 50 years. This organization began as the U.S. Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of the Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of three thousand dollars.

Most recently, it became internationally known as the U.S. Army Environmental Hygiene Agency (AEHA). Its mission expanded to support worldwide preventive medicine programs of the Army, DOD, and other Federal agencies as directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission of providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The organization's quest has always been one of excellence and the provision of quality service. Today, its goal is to be an established world-class center of excellence for achieving and maintaining a fit, healthy, and ready force. To achieve that end, the CHPPM holds firmly to its values which are steeped in rich military heritage:

★ *Integrity is the foundation*
★ *Excellence is the standard*
★ *Customer satisfaction is the focus*
★ *Its people are the most valued resource*
★ *Continuous quality improvement is the pathway*

This organization stands on the threshold of even greater challenges and responsibilities. It has been reorganized and reengineered to support the Army of the future. The CHPPM now has three direct support activities located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fitzsimons Army Medical Center, Aurora, Colorado; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of CHPPM's increasing global mission. As CHPPM moves into the 21st Century, new programs relating to fitness, health promotion, wellness, and disease surveillance are being added. As always, CHPPM stands firm in its commitment to Army readiness. It is an organization proud of its fine history, yet equally excited about its challenging future.

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13. ABSTRACT *(Maximum 200 words)*

In October 1998, The U.S. Army Physical Fitness School Coordinated with the U.S. Army Center for Health Promotion and Preventive Medicine Epidemiology Program to evaluate the current standards for entry into the Fitness Training Unit at Fort Jackson, South Carolina. An epidemiologic consultation was initiated to assist in determining the minimum fitness criteria for entry into basic combat training (BCT) based on injury incidence. Past studies suggested that injury risk would be highest among the least-fit trainees and that it might be possible to identify a fitness level at which injury risk stabilized. The study cohort consisted of 655 male and 498 female basic trainees. Fitness was determined by performance on an Army Physical Fitness Test (APFT) administered at the reception station. Data on injuries sustained during BCT were collected from trainee medical records at the conclusion of the BCT cycle. The analysis revealed that the least aerobically-fit women (slowest half of run times) were 2.2 to 2.8 times more likely than the most aerobically-fit women (fastest half) to sustain any injury during basic training ($p < 0.01$) and were twice as likely to sustain an injury resulting in one or more days of limited duty ($p = 0.01$). The results for men showed similar trends; injury incidence decreased progressively with increasing aerobic performance (faster run times). Injury risk stabilized at the following performance levels: 17-minute two-mile run for both men and women, 26 sit-ups for men, and 10 push-ups for men. There were no injury incidence patterns associated with female push-up or sit-up performance. These data indicate that there were specific APFT performance levels at which further increases in performance did not result in reduction of injury risk. A secondary analysis was performed to assess the relationship between entry-level physical fitness, injury, and completion of BCT. The most important predictor of on-time graduation was entry-level run time for men and time-loss injury during BCT for women. Further research is needed to validate these results and to determine the APAFT performance levels at which improvements in fitness reduces injuries in BCT.

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EXECUTIVE SUMMARY
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DETERMINING PHYSICAL FITNESS CRITERIA FOR ENTRY INTO ARMY BASIC COMBAT TRAINING: CAN THESE CRITERIA BE BASED ON INJURY RISK? FORT JACKSON, SOUTH CAROLINA, 1998

1. INTRODUCTION. In May 1998, the U.S. Army Physical Fitness School (USAPFS) was tasked by the Training and Doctrine Command (TRADOC) to evaluate existing Fitness Training Units, to provide information to help standardize their entry and exit requirements and lengths of stay, and to recommend what Army Physical Fitness Test (APFT) event(s) should be used for the entry and exit requirements. In October 1998, the USAPFS coordinated with the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Epidemiology Program for assistance with this tasking. The USACHPPM Epidemiology Program collected and analyzed medical and fitness data on basic trainees at Fort Jackson, South Carolina. This report describes the results of the USACHPPM epidemiologic investigation.

2. PURPOSE. The primary purposes of this project were to determine the relationship between injuries and entry-level physical fitness among basic trainees as measured by performance on the first diagnostic APFT, and to identify fitness levels at which at which injury risk stabilized. A secondary purpose was to assess the relationships between entry-level fitness, injury, and completion of an uninterrupted basic combat training (BCT) cycle.

3. METHODS.

a. A historical prospective design was used. Persons eligible for this study were men and women participating in gender-integrated Army BCT as part of the 2nd Battalion, 28th Infantry Regiment (2-28th Bn) at Fort Jackson, South Carolina between 16 October 1998 and 16 December 1998. The study cohort was defined as all trainees in the 2-28th Bn on whom we collected a medical record (655 men, 498 women). An injury case was defined as a trainee who sustained an overuse or traumatic injury during BCT that was recorded in the medical record. A time-loss injury case was defined as a trainee who sustained an overuse or traumatic injury during BCT that resulted in one or more days of limited duty.

b. Descriptive information (gender, age, ethnicity, height, and weight) and data on each visit to a health care provider was collected from the trainees' medical records. For each visit, the following was recorded: diagnosis, body part injured, side of body injured, days of limited duty received, and disposition received. Results of the first diagnostic APFT (2-mile run time, sit-ups, and push-ups) were obtained from a database maintained by each company.

c. Descriptive statistics and injury incidence were calculated. The relationship of specific risk factors with any injury (yes/no) and time-loss injury (yes/no) was assessed. A 'cutpoint analysis' was performed to evaluate the association between injury and specific APFT performance levels. A cutpoint analysis was also used to explore the association among entry-level fitness, injury, and completion of an uninterrupted BCT cycle.

4. RESULTS.

a. *Injury Incidence During BCT.* Women were more than twice as likely as men to sustain any injury during basic training and were 2.6 times more likely to sustain a time-loss injury. Women had four times the risk of an injury that resulted in reassignment to the PTRP.

b. *Entry-Level Fitness and Injury During BCT.* There were no statistically significant predictors of any injury for men. Age was a weak predictor of time-loss injury for men. Among women, run time was the best predictor of any injury and time-loss injury. The slowest half of female trainees (2-mile run time less than 21.26 minutes) were 2.2 to 2.8 times more likely to sustain any injury and twice as likely to sustain a time-loss injury. 'Cutpoint analysis' identified performance levels at which any injury or time-loss injury risk stabilized: 17-minute 2-mile run for both men and women, 26 sit-ups for men, and 10 push-ups for men. At these performance level cutpoints and higher, injury risk for the more fit trainees did not differ from injury risk among the less fit trainees.

c. *Entry-level Fitness and Completion of an Uninterrupted BCT Cycle.* The 2-mile run time on the first diagnostic APFT had an inverse relationship with completion of BCT in 9 weeks for men; for every 1-minute decrease in run time, the odds of completing BCT in 9 weeks were increased by approximately 20%. Female trainees who did not sustain a time-loss injury during BCT were four times more likely to complete BCT in 9 weeks. Younger age, more sit-ups, and faster run times were weak predictors of on-time graduation for women as well. 'Cutpoint analysis' revealed trends in on-time graduation incidence for three first diagnostic APFT events. From the performance level cutpoints of 19- to 26-minute run times for women, the difference in graduation incidence between the less fit and the more fit trainees was negligible. For men, from the performance level cutpoints of 14 to 22 minutes, there was little difference in graduation incidence between the less fit and the more fit trainees. From 8 to 26 push-up repetitions, incidence of on-time graduation was higher for those men performing more push-ups as compared to those men performing less.

5. CONCLUSIONS and RECOMMENDATIONS.

a. Though greater physical fitness has been related to lower injury risk among basic trainees, it appears that injury risk stabilizes at particular APFT performance levels such that individuals performing above this level do not have lower injury risks compared to their less fit peers. The following performance levels represent thresholds below which injury risk was higher and above which there is minimal change in injury risk:

(1) For both men and women, 2-mile run time of 17 minutes on the first diagnostic APFT.

(2) For men only, completion of 26 sit-ups on the first diagnostic APFT.

(3) For men only, completion of 10 push-ups on the first diagnostic APFT.

b. No push-up and sit-up performance criteria are suggested for women since neither was associated with injury risk during BCT in this study.

c. Further research is needed to duplicate these findings (APFT performance levels at which injury risk stabilizes and predictors of on-time BCT completion) and to determine if improvements in entry-level fitness can reduce injury rates during BCT.

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1. REFERENCES. Appendix A contains a list of references used in this report.

2. INTRODUCTION. In May 1998, the U.S. Army Physical Fitness School (USAPFS) was tasked by the Training and Doctrine Command (TRADOC) to evaluate existing fitness training units (FTUs), standardize their entry and exit requirements and lengths of stay, and determine what Army Physical Fitness Test (APFT) event(s) should be used for the entry and exit requirements. In October 1998, the USAPFS coordinated with the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Epidemiology Program for assistance with data collection and analysis of medical and fitness data on a portion of this study conducted at Fort Jackson, South Carolina.

3. BACKGROUND

a. Past studies have shown that injuries are common in basic combat training (BCT). Injury incidence among men in basic training has ranged from 23-37%, and from 42-67% among women. [1-6] Injuries also result in considerable lost training time. [5,7,8] During basic training, a very rigid schedule must be followed in order to complete the requirements for graduation. When training is missed due to injury and the trainee does not complete required events, the need to "restart" this trainee in another unit results. This lengthens the amount of time spent in basic training and further strains already-limited resources. An injury may also result in discharge from service. A recent study of basic trainees at Fort Jackson attributed 24% of male discharges and 30% of female discharges to medical conditions. [5]

b. The association of injury during BCT and fitness upon entry to the Army, as measured by performance on the first diagnostic APFT, has been evaluated in numerous basic training populations. [4-6,9-11] The 2-mile run time has been found to be a valid estimate of maximal oxygen consumption (VO_2 max), [12] the "gold standard" of physiologic measures of aerobic capacity, and thus is used as a surrogate measure of aerobic fitness. In all of these studies, poor aerobic fitness (slow run time on the first diagnostic APFT) was associated with injury during BCT for men and/or women. [4-6,9-11] The push-up and sit-up APFT events are measures of muscle endurance. [12]

Although sit-up performance shows no consistent association with injury during BCT, an association between injury and push-up performance on the first diagnostic APFT for men has been demonstrated. [5,11]

c. One means of decreasing injury rates may be to improve the fitness of incoming recruits. In 1985, the FTU was established at Fort Jackson for this purpose. [13] Incoming recruits who did not meet fitness requirements for BCT were sent directly to the FTU, where they focused on physical training for 3 days to 3 weeks or more prior to entering basic training. The goal of the FTU is to prepare recruits for the physical demands of BCT. From 1985-1997, those recruits who failed the APFT push-up requirement at the reception station were sent to the FTU. In January 1998, the reception station test was changed to include a push-up, sit-up and run event. [13] Table 1 lists the FTU entry and exit requirements during 1998. The rationale for these particular criteria is not known. [13]

Table 1. FTU entry and exit requirements, January 1998-present

APFT event	Men		Women	
	Entry	Exit	Entry	Exit
1-mile run (minutes)	8.5	8.5	11.0	11.0
Sit-ups (number completed)	17	21	17	21
Push-ups (number completed)	13	18	3	5

d. To date, only one published study has evaluated the effects of participation in the FTU on fitness and injury rates in basic training. [14] DiBenedetto reported that injury sick call rates during basic training among prior FTU participants was higher than non-participants, despite improvements in fitness during the three weeks they spent in the FTU. [14] Results from the final APFT completed at the conclusion of BCT showed that FTU participants never attained the fitness level (push-ups and run time) of non-participants. DiBenedetto suggested that FTU exit requirements might need to be raised in order to achieve the desired effect of lowering injury incidence in basic training. [14]

e. During the DiBenedetto study, the criteria to enter and exit the FTU was based on push-up performance only. As mentioned previously, the criteria were changed in January 1998 to include tests for sit-ups and run times in addition to push-ups (Table 1). A 1998 study by Knapik and coworkers compared women coming from the FTU to those who did not have to go to the FTU. [5] On their first APFT in BCT, the FTU and non-FTU women had almost identical mean run times. During BCT, injury incidence was also almost identical in these two groups. This suggested that women of similar aerobic fitness levels had similar injury risks.

f. Reduction of injury rates may not be the only outcome of interest. Another outcome that has been discussed is completion of BCT in one, uninterrupted cycle. In 1998, only 77% of basic trainees at Fort Jackson graduated in 8 weeks (the length of a complete, uninterrupted basic training cycle at that time). [5] The remainder of the trainees were discharged, restarted, or sent to the Physical Training and Rehabilitation Program (PTRP).

g. On-time completion of BCT is a desirable goal in an era of limited resources. When basic training time is extended due to injury or inability to meet physical fitness standards, more money and resources must be spent to train that recruit. In 1994, the United States Army Infantry Training Center estimated that the cost to the Government of a single recruit who does not make it through infantry basic training, a 13-week program, was $16,000. [15] Since then, the costs of training have risen. In 1998, the General Accounting Office reported that the average cost across all services of training an enlistee was $28,800. [16] Increasing the number of recruits able to complete BCT on time would save training dollars and more efficiently populate units in need of soldiers, thus increasing the probability of mission success.

h. Snoddy and Henderson [15] found that the most consistent predictors of training completion were performance on the initial APFT and cigarette smoking history. Compared to those who did not complete BCT, those who completed training were more likely to be nonsmokers, have faster run times, and perform more push-ups and sit-ups on the initial APFT. [15] The more fit, nonsmokers also had fewer clinic visits and less profile time during basic training. [15]

i. A 1998 study of basic trainees at Fort Jackson took a slightly different perspective by examining predictors of discharge. [5] This study showed that women who completed fewer push-ups and had a slower run time on the first diagnostic APFT were more likely to be discharged than those women with better first diagnostic APFT results. [5] Other predictors of discharge for women were lower rank, white or black ethnicity, and lower educational level. For men, lower educational level and low performance on the push-up component of the first diagnostic APFT were associated with discharge. Slower run time was of borderline significance with risk of discharge for men. [5]

4. PURPOSE. The primary purposes of this study were to determine the relationship between injuries and entry-level physical fitness among basic trainees as measured by performance on the first diagnostic APFT, and to identify specific APFT performance levels at which further increases in performance did not result in a reduction of injury risk. A secondary purpose of this study was to assess the relationships between entry-level fitness, injury, and completion of an uninterrupted BCT cycle in order to identify first diagnostic APFT performance levels at which a trainee would be more likely to complete an uninterrupted BCT cycle.

5. METHODS.

a. Subjects, Data Collection, and Procedures.

(1) The persons eligible for this study were men and women participating in gender-integrated Army BCT as part of the 2nd Battalion, 28th Infantry Regiment (2-28th Bn) at Fort Jackson, South Carolina between 16 October 1998 and 16 December 1998. This battalion was the first at Fort Jackson to have a 9-week BCT cycle (previously only 8 weeks). Each of the five companies in this Battalion followed a similar training schedule that required the recruits to successfully complete 18 training requirements in order to graduate BCT (listed in Appendix B).

(2) While in BCT, trainees reported as needed to sick call held at the battalion. At sick call, a medic assessed their injury or illness and either provided treatment or referred the trainee to the troop medical clinic for further evaluation. At the troop medical clinic, the trainee typically saw a physician's assistant or medical doctor. If necessary, the trainee was referred to a physical therapist or other specialist. Alternatively, when the clinic was not open, trainees could enter the medical system by reporting to the Treatment Referral Area of Fort Jackson's Moncrief Army Community Hospital. A record of contact with any medical personnel (medic, physician's assistant, physician, physical therapist, etc.) was filed in the trainee medical record.

(3) Data on each visit to a health care provider was collected from the trainee's medical records. For each visit, the following was recorded: diagnosis, body part injured, side of body injured, days of limited duty received, and disposition received. Descriptive information (gender, age, ethnicity, height, and weight) was also collected from the medical record (physical examination form).

(4) Normally, trainees take a special fitness test at the reception station. If the criteria described in Table 1 were not met, the trainee entered the FTU; if the trainee passed the test, he/she went on to BCT. For the purposes of this study, all trainees took the regular APFT and went on to BCT regardless of their performance. This was done to ensure that the least-fit trainees were included in this study. The APFT consisted of a 2-mile run for time, the number of push-ups completed in 2 minutes, and the number of sit-ups completed in 2 minutes.

(5) The study cohort was defined as all trainees in the 2-28th Bn for whom we collected a medical record. An illness case was defined as a trainee who sustained a respiratory, gastrointestinal, or other general medical complaint that was recorded in the medical record. The injury definitions used were consistent with those used in several earlier studies. [5,11] A trainee was defined as an injury case if he/she sustained an overuse or traumatic injury during BCT that was recorded in the medical record (hereafter referred to as 'any injury'). This definition includes overuse injuries (tissue damage resulting from repetitive, cumulative

microtrauma) such as non-specific musculoskeletal pain, strains, stress fractures, and tendinitis as well as traumatic injuries (tissue damage resulting from sudden, overload trauma) such as sprains, fractures, contusions, and lacerations. This definition excludes environmental injuries such as insect bites, animal bites, heat injury, and cold injury. A 'time-loss injury' case was defined as a trainee who sustained an overuse or traumatic injury resulting in one or more days of limited duty.

(6) A trainee whose injury resulted in re-assignment to the PTRP was defined as a 'PTRP injury' case. In general, trainees sent to the PTRP are injured to the extent that they will miss a considerable amount of training (1 week or more). Trainees in the PTRP underwent individual and group training appropriate for their injury in order to maintain a minimal fitness level while recovering from the injury. The trainee remained in the PTRP until a medical care provider, usually a physical therapist, determined that the trainee was able to return to BCT. At that point, the trainee was transferred to a BCT battalion in which the trainee was able to complete his/her remaining requirements for graduation from BCT.

b. Data Analysis.

(1) Descriptive statistics and injury risk estimates for the measured risk factors were generated. Injury incidence was defined as the percentage of male or female trainees with one or more injuries (numerator) divided by the total number of male or female trainees in the cohort (denominator). A chi-square test was used to assess the association of specific risk factors with any injury (yes/no) and time-loss injury (yes/no). Where appropriate (where data were ordinal), the Mantel Haenszel chi-square test for trend was used to assess the statistical significance of data trends. Next, a backward-stepping logistic regression was conducted to determine the relationship of multiple risk factors with any injury and time-loss injury. Physical characteristics (height, weight), demographic variables (rank, race, age), categorical variables of first diagnostic APFT results (quartiles of run time, sit-ups, push-ups), and a categorical variable for illness (yes/no) were considered in the model. First diagnostic APFT results were divided into quartiles (four groups of similar size) instead of keeping them as continuous variables because of the nonlinear relationship between injury and fitness (see Appendix C). The least fit trainees (slowest runners and those that complete the least number of push-ups and sit-ups) have a disproportionately greater injury incidence, which can be diluted if the APFT results are kept continuous. All analyses were conducted separately for men and women using SPSS (version 9.0.0) statistical software.

(2) A 'cutpoint analysis' was performed to assess the association between injury and specific APFT performance levels. Injury incidence among trainees above and below selected APFT performance levels, or cutpoints, were compared using a chi-square test statistic. For example, the injury incidence among male trainees who completed fewer than seven push-ups on the APFT was compared to the injury incidence of those male trainees completing seven or more push-ups. A significant difference in injury incidence indicated that performance differed

above and below the seven push-up level. This process was continued until the difference in injury incidence between those above and those below the selected performance level was minimal or no pattern could be determined. Statistical significance was determined at the 90% confidence level ($p \leq 0.10$). The injury risk ratio at each performance level was calculated by dividing the injury incidence in the more fit group (faster run or more push-ups or sit-ups) by the injury incidence in the less fit group (slower run or fewer push-ups or sit-ups). Cutpoint analysis was completed for the outcomes 'any injury' and 'time-loss injury.' The number of PTRP injuries was too small to perform a cutpoint analysis.

(3) A 'cutpoint analysis' was also used to explore the association between entry-level fitness and completion of an uninterrupted BCT cycle. The incidence of completion of an uninterrupted BCT cycle was defined as the percentage of male or female trainees who completed BCT in 9 consecutive weeks in the 2-28th Bn (numerator) divided by the total number of male or female trainees in the cohort (denominator). To assess the association between fitness on entry to BCT (represented by first diagnostic APFT performance) and uninterrupted completion of BCT, the chi square test statistic was used to compare BCT completion incidences among trainees above and below selected APFT performance levels. Statistical significance of the chi-square statistic was determined at the 90% confidence level ($p \leq 0.10$). This process was continued until the difference in BCT completion incidences between trainees above and trainees below the selected performance level was minimal or no pattern could be determined. The BCT completion ratio at each performance level was calculated by dividing the BCT completion incidence in the more fit group (faster run or more push-ups or sit-ups) by the BCT completion incidence in the less fit group (slower run or fewer push-ups or sit-ups).

(4) In addition, a multivariate analysis using backward-stepping logistic regression was conducted for BCT completion. Physical characteristics (height, weight), demographic variables (rank, race, age), first diagnostic APFT results (run time, sit-ups, push-ups) and a categorical variable for illness (yes/no) were considered in the model. Due to the association of run time and injury among women, an interaction term was considered for the model for women.

6. RESULTS.

a. The Study Cohort. Of the 685 male and 541 female recruits in 2-28th Bn, we obtained medical records for 655 (96%) men and 498 (92%) women. These 655 men and 498 women were defined as the cohort. Results of the first diagnostic APFT were obtained for 604 men and 445 women.

b. Demographic and Physical Characteristics of Recruits in the Cohort. Table 2 shows the physical characteristics of the cohort. Men and women were, on average, approximately 20 years of age. As would be expected, men were taller and heavier than women. Men also had

a higher body mass index compared to women. Table 3 illustrates the demographic make-up of this cohort. More than half of the men were white. Among women, the number of white and black recruits was approximately equal. The majority of recruits in the cohort entered basic training as an E-1 in the Regular Army. About one third of the men and women were in the Army Reserve or National Guard.

Table 2. Physical characteristics of the cohort

Characteristic	Men		Women	
	n	Mean(SD)	n	Mean(SD)
Age (years)	655	19.9(3.1)	496	20.2(3.9)
Stature (cm)	651	176.2(7.2)	497	163.7(6.7)
Body mass (kg)	651	74.6(13.2)	497	61.2(9.7)
Body mass index (kg/m^2)	651	24.0(3.7)	497	22.8(3.1)

SD=standard deviation

Table 3. Demographic characteristics of the cohort

Characteristic		Men		Women	
		n	Proportion (%)	n	Proportion (%)
Race	White	376	57.4	204	41.0
	Black	171	26.1	201	40.4
	Other	86	13.9	84	17.0
	Unknown	17	2.6	8	1.6
Rank	E-1	436	66.6	299	60.0
	E-2	114	17.4	103	20.7
	E-3	75	11.5	58	11.6
	E-4	19	2.9	22	4.4
Component	Regular Army	443	68.4	327	66.6
	Army Reserve	85	18.5	93	18.9
	National Guard	120	13.1	71	14.5

c. First Diagnostic APFT Events. Table 4 shows the means and standard deviations for two-mile run times, sit-ups, and push-ups completed on the first diagnostic APFT. Men ran 27% faster and performed 62% more push-ups, and 16% more sit-ups than women. Approximately 6% of male run times and 2% of female run times were missing from the company data file for reasons unknown to the investigators.

Table 4. First diagnostic APFT* results for men and women in the cohort

APFT event	Men		Women	
	n	Mean (SD)	n	Mean (SD)
Two-mile run time (minutes)	565	16.9 (2.6)	438	21.5 (3.2)
Push-ups completed in 2 minutes (n)	604	34 (14)	445	13 (9)
Sit-ups completed in 2 minutes (n)	603	43 (13)	445	36 (15)

*This APFT was taken at the reception station.
SD = standard deviation

d. Injury Incidence During BCT. Table 5 presents the incidence of any injury, time-loss injury, and PTRP injury among the male and female recruits in the cohort. Women were more than twice as likely as men to sustain any injury during basic training and were 2.6 times more likely to sustain a time-loss injury. Women had four times the risk of an injury resulting in re-assignment to the PTRP.

Table 5. Incidence (%) of any injury, time-loss injury, and PTRP injury during BCT*

Injury Type	Men (n=655)	Women (n=498)	Injury risk ratio (women vs. men)
Any injury (%)	29.9	65.3	2.1
Time-loss (profile) injury (%)	19.8	51.2	2.6
PTRP admission due to injury (%)	2.3	9.4	4.1

*9 weeks, Fort Jackson, SC, fall 1998

e. Entry-level Fitness and Injury During BCT.

(1) Univariate analysis of the relationships between injury and run time, push-ups, or sit-ups on the first diagnostic APFT revealed no statistical associations with any injury or time-loss injury for men (Table 6). However, trend analysis revealed an increasing injury incidence with increasing run time. Statistically significant associations were observed between run time and any injury and run time and time-loss injury for women (Table 7). The relationship between injury incidence and 2-mile run time is demonstrated graphically in Appendix C. Multivariate analysis (logistic regression) indicated that age was a weak predictor of time-loss injury for men (Table 8). For women (Table 9), run time was the best predictor of any injury and time-loss injury. Specifically, the slowest half of women (run time of 21.25 minutes or more) were 2.2 to 2.8 times more likely than faster women to sustain any injury and twice as likely to sustain a time-loss injury.

Table 6. Association of any injury and time-loss injury with first diagnostic APFT results, men

Variable	Quartiles	No. of trainees in quartile	Any injury incidence (%)	Chi-square p-value/p-value for trend	Time-loss injury incidence (%)	Chi-square p-value/p-value for trend
First diagnostic 2-Mile Run	<15.00 mins	143	23.8	0.37/0.09	14.7	0.16/0.06
	15.01-16.67	140	27.1		15.0	
	16.68-18.29	141	25.5		15.6	
	>18.30	141	32.6		23.4	
First diagnostic Sit-ups	<34 reps	151	29.8	0.49/0.46	19.2	0.21/0.42
	34-42	152	27.6		18.4	
	43-51	151	26.5		16.6	
	>51	149	26.2		16.1	
First diagnostic Push-ups	<25 reps	150	26.0	0.36/0.51	18.0	0.25/0.16
	25-32	158	32.9		21.5	
	33-42	147	25.9		17.7	
	>42	149	24.8		12.8	

Table 7. Association of any injury and time-loss injury with first diagnostic APFT results, women

Variable	Quartiles	No. of trainees in quartile	Any injury incidence (%)	Chi-square p-value/p-value for trend	Time-loss injury incidence (%)	Chi-square p-value/p-value for trend
First diagnostic 2-Mile Run	<19.34 mins	107	47.7	0.00/0.00	35.5	0.02/0.00
	19.34-21.25	110	60.9		45.5	
	21.26-23.63	108	71.3		54.6	
	>23.63	108	68.5		53.7	
First diagnostic Sit-ups	<26 reps	113	52.2	0.51/0.24	67.3	0.43/0.11
	26-35	111	52.3		66.7	
	36-46	116	44.0		61.2	
	>46	105	46.7		58.1	
First diagnostic Push-ups	<6 reps	108	63.8	0.46/0.26	45.4	0.37/0.22
	6-12	119	68.1		54.6	
	13-17	101	63.4		50.5	
	>17	117	58.1		55.5	

Table 8. Adjusted odds ratios and 90% confidence intervals (CI) for variables associated with *time-loss injury* during BCT*, men

Variable associated with time-loss injury during BCT	p-value for Wald statistic	Odds ratio	90% CI
Age (years)	0.09	1.1	1.0, 1.1

*No variables were statistically associated with any injury during BCT at the 90% confidence level.

Table 9. Adjusted odds ratios and 90% confidence intervals (CI) for variables associated with *any injury* during BCT, women

Variable associated with any injury during BCT	p-value for Wald statistic	Odds ratio	90% CI
2-mile run time on the first diagnostic APFT			
Quartile 1: 11.75-19.32 minutes	--	1.0	--
Quartile 2: 19.33-21.24	0.12	1.6	1.0, 2.5
Quartile 3: 21.25-23.62	0.001	2.8	1.7, 4.5
Quartile 4: 23.63 or more	0.01	2.2	1.4, 3.6

Table 10. Adjusted odds ratios and 90% confidence intervals (CI) for variables associated with *time-loss injury* during BCT, women

Variable associated with time-loss injury during BCT	p-value for Wald statistic	Odds ratio	90% CI
2-mile run time on the first diagnostic APFT			
Quartile 1: 11.75-19.32 minutes	--	1.0	--
Quartile 2: 19.33-21.24	0.35	1.3	0.8, 2.1
Quartile 3: 21.25-23.62	0.01	2.0	1.3, 3.3
Quartile 4: 23.63 or more	0.01	2.0	1.3, 3.2

(2) Table 11 displays the results of the 'cutpoint analysis' for any injury among male trainees. A statistically significant difference in injury risk between slower runners and faster runners occurred only at the 20-minute cutpoint, though a trend of increasing injury risk with increasing increments of run time is seen. For sit-ups, there were statistically significant differences in any injury risk among male trainees performing above and below 14-repetition cutpoint and these differences continued up to 24 repetitions. An exception was found at the 16-repetition performance level, though injury incidence was still higher for those performing fewer than 16 repetitions. For push-ups, a statistically significant difference in injury risk was observed between those performing greater than or equal to 8 repetitions and those performing less than 8 repetitions. A difference was maintained up to 10 repetitions.

Table 11. Entry-level fitness* and risk of *any injury* in basic training: a comparison of injury incidence above and below selected APFT performance levels, men

2-mile run time performance level (minutes) n=565	N above performance level (slower)	% with any injury (slower)	N below performance level (faster)	% with any injury (faster)	Risk ratio (slower/ faster)	Chi-squar p-value
22	16	37.5	549	27.0	1.4	0.35
21	32	34.4	533	26.8	1.3	0.35
20	56	37.5	509	26.1	1.4	0.07
19	105	33.3	460	25.9	1.3	0.12
18	171	31.6	394	25.4	1.2	0.13
17	255	29.8	310	25.2	1.2	0.22
16	336	28.3	229	25.8	1.1	0.51
15	422	28.4	143	23.8	1.2	0.28
14	500	27.3	65	26.2	1.0	0.83
Sit-ups performance level (# completed) n=603	**N below performance level (less)**	**% with any injury (less)**	**N above performance level (more)**	**% with any injury (more)**	**Risk ratio (less/more)**	**Chi-squar p-value**
14	7	57.1	596	27.2	2.1	0.08
16	11	45.5	592	27.2	1.7	0.18
18	12	50.0	591	27.1	1.8	0.08
20	17	47.1	586	27.0	1.7	0.07
22	31	41.9	572	26.7	1.6	0.07
24	43	39.5	560	26.6	1.5	0.07
26	54	31.5	549	27.1	1.2	0.50
28	68	35.3	535	26.5	1.3	0.13
30	84	33.3	519	26.6	1.3	0.20
32	116	31.0	487	26.7	1.2	0.35
Push-ups performance level (# completed) n=604	**N below performance level (less)**	**% with any injury (less)**	**N above performance level (more)**	**% with any injury (more)**	**Risk ratio (less/more)**	**Chi-squar p-value**
8	15	60.0	589	26.7	2.2	0.00
9	16	56.3	588	26.7	2.1	0.01
10	19	47.4	585	26.8	1.8	0.05
11	22	40.9	582	27.0	1.5	0.15
12	26	34.6	578	27.2	1.3	0.41
13	28	35.7	576	27.1	1.3	0.32
14	36	36.1	568	26.9	1.3	0.23
15	44	34.1	560	27.0	1.3	0.31
16	54	33.3	550	26.9	1.2	0.31
17	61	29.5	543	27.3	1.1	0.71
18	68	27.9	536	27.4	1.0	0.93

*Entry-level fitness as measured by the first diagnostic APFT.

(3) Table 12 displays the results of the cutpoint analysis for time-loss injuries among male recruits. For the run, statistically significant differences in injury risk were demonstrated at 18 minutes and differences remained through 21 minutes. The slower male run groups had a 40 to 90 percent greater risk of injury as compared to their faster counterparts. There was no consistent relationship between performance on the sit-up event and time-loss injury. Push-up performance, however, showed a strong relationship with time-loss injury incidence. There were statistically significant differences in time-loss injury risk between those men who performed above and below the cutpoints of 8 to 11 repetitions. Though the differences in injury risk were not statistically significant beyond 11 repetitions, the data show that injury risk was lower with higher push-up performance level.

(4) Tables 13 and 14 contain the results of the injury risk cutpoint analysis for female recruits. Table 13 shows that, for women with 2-mile run times of 17 to 26 minutes, slower runners were at a greater risk of any injury as compared to their faster female counterparts. No statistically significant differences in injury risk among the more fit verses the less fit recruits were demonstrated at any sit-up or push-up performance levels.

(5) Time-loss injury risk ratios comparing women above and below selected APFT performance levels are shown in Table 14. As with risk of any injury, statistically significant differences in time-loss injury risk among women above and women below run time performance levels were seen at each cutpoint from 17 to 26 minutes. Time-loss injury risk was not significantly associated with sit-up and push-up performance levels for women.

f. Entry-level Fitness and Completion of an Uninterrupted BCT Cycle.

(1) In this population, 585 (11%) male trainees and 389 (22%) female trainees did not complete training in 9 continuous weeks with the 2-28th Bn. The physical, demographic, and fitness characteristics of trainees completing BCT on time (Tables 15, 16, and 17) were similar to the characteristics of the cohort (Tables 2, 3, and 4). Most men and women who completed an uninterrupted BCT cycle were an E-1 in the Regular Army. The majority of men were white, while there were slightly more black women who completed BCT on time as compared to whites and other races. The APFT results for both men and women who completed BCT on time were similar to the results for the entire cohort.

Table 12. Entry-level fitness* and risk of *time-loss injury* in basic training: a comparison of time-loss injury incidence above and below selected APFT performance levels, men

2-mile run time performance level (minutes) n=565	**N above performance level (slower)**	**% with time-loss injury (slower)**	**N below performance level (faster)**	**% with time-loss injury (faster)**	**Risk ratio (slower/ faster)**	**Chi-square p-value**
22	16	31.3	549	16.8	1.9	0.13
21	32	31.3	533	16.3	1.9	0.03
20	56	30.4	509	15.7	1.9	0.01
19	105	25.7	460	15.2	1.7	0.01
18	171	22.2	394	15.0	1.5	0.04
17	255	20.0	310	14.8	1.4	0.11
16	336	18.5	229	15.3	1.2	0.33
15	422	18.0	143	14.7	1.2	0.36
14	500	17.2	65	16.9	1.0	0.96
Sit-ups performance level (# completed) n=603	**N below performance level (less)**	**% with time-loss injury (less)**	**N above performance level (more)**	**% with time-loss injury (more)**	**Risk ratio (less/more)**	**Chi-square p-value**
14	7	14.3	596	17.6	0.8	0.82
16	11	18.2	592	17.6	1.0	0.96
18	12	25.0	591	17.4	1.4	0.50
20	17	29.4	586	17.2	1.7	0.19
22	31	32.3	572	16.8	1.9	0.03
24	43	25.6	560	17.0	1.5	0.15
26	54	20.4	549	17.3	1.2	0.57
28	68	23.5	535	16.8	1.4	0.17
30	84	22.6	519	16.8	1.3	0.19
32	116	18.1	487	17.5	1.0	0.87
Push-ups performance level (# completed) n=604	**N below performance level (less)**	**% with time-loss injury (less)**	**N above performance level (more)**	**% with time-loss injury (more)**	**Risk ratio (less/more)**	**Chi-square p-value**
8	15	46.7	589	16.8	2.8	0.00
9	16	43.8	588	16.8	2.6	0.01
10	19	36.8	585	16.9	2.2	0.03
11	22	31.8	582	17.0	1.9	0.07
12	26	26.9	578	17.1	1.6	0.20
13	28	28.6	576	17.0	1.7	0.12
14	36	27.8	568	16.9	1.6	0.10
15	44	25.0	560	17.0	1.5	0.20
16	54	25.9	550	16.7	1.6	0.09
17	61	23.0	543	16.9	1.4	0.24
18	68	20.6	536	17.2	1.2	0.48

*Entry-level fitness as measured by the first diagnostic APFT.

Table 13. Entry-level fitness* and risk of *any injury* in basic training: a comparison of injury incidence above and below selected APFT performance levels, women

2-mile run time performance level (minutes) n=438	N above performance level (slower)	% with any injury (slower)	N below performance level (faster)	% with any injury (faster)	Risk ratio (slower/ faster)	Chi-square p-value
26	33	78.8	405	61.2	1.3	0.05
25	53	77.4	385	60.5	1.3	0.02
24	88	71.6	350	60.3	1.2	0.05
23	129	71.3	309	58.9	1.2	0.01
22	176	70.5	262	57.3	1.2	0.01
21	233	69.1	205	55.1	1.3	0.00
20	287	69.0	151	50.3	1.4	0.00
19	336	67.3	102	47.1	1.4	0.00
18	377	64.7	61	49.2	1.3	0.02
17	408	63.7	30	46.7	1.4	0.06
16	422	62.6	16	62.5	1.0	0.99
15	431	62.4	7	71.4	0.9	0.63
Sit-ups performance level (# completed) n=445	**N below performance level (less)**	**% with any injury (less)**	**N above performance level (more)**	**% with any injury (more)**	**Risk ratio (less/more)**	**Chi-square p-value**
14	30	56.7	415	63.9	0.9	0.43
16	37	59.5	408	63.7	0.9	0.61
18	52	63.5	393	63.4	1.0	0.99
20	62	62.9	383	63.4	1.0	0.93
22	79	63.3	366	63.4	1.0	0.99
24	96	65.6	349	62.8	1.0	0.61
26	113	67.3	332	62.0	1.1	0.32
28	133	66.2	312	62.2	1.1	0.42
Push-ups performance level (# completed) n=445	**N below performance level (less)**	**% with any injury (less)**	**N above performance level (more)**	**% with any injury (more)**	**Risk ratio (less/more)**	**Chi-square p-value**
2	36	61.1	409	63.6	1.0	0.75
4	64	64.1	381	63.3	1.0	0.90
6	108	63.9	337	63.2	1.0	0.90
8	144	64.6	301	62.8	1.0	0.71
10	176	63.1	269	63.6	1.0	0.92
12	214	65.9	231	61.0	1.1	0.29
14	254	66.1	191	59.7	1.1	0.16
16	294	64.3	151	61.6	1.0	0.58
18	328	65.2	117	58.1	1.1	0.17

*Entry-level fitness as measured by the first diagnostic APFT.

Table 14. Entry-level fitness* and risk of *time-loss injury* in basic training*: a comparison of time-loss injury incidence above and below selected APFT performance levels, women

2-mile run time performance level (minutes) n=438	N above performance level (slower)	% with time-loss injury (slower)	N below performance level (faster)	% with time-loss injury (faster)	Risk ratio (slower/ faster)	Chi-square p value
26	33	63.6	405	46.4	1.4	0.06
25	53	62.3	385	45.7	1.4	0.02
24	88	55.7	350	45.7	1.2	0.09
23	129	55.8	309	44.3	1.3	0.03
22	176	55.1	262	42.7	1.3	0.01
21	233	52.8	205	42.0	1.3	0.02
20	287	52.3	151	39.1	1.3	0.01
19	336	51.5	102	35.3	1.5	0.00
18	377	49.3	61	37.7	1.3	0.08
17	408	48.8	30	33.3	1.5	0.10
16	422	47.6	16	50.0	1.0	0.87
15	431	47.6	7	57.1	0.8	0.62
Sit-ups performance level (# completed) n=445	**N below performance level (less)**	**% with time-loss injury (less)**	**N above performance level (more)**	**% with time-loss injury (more)**	**Risk ratio (less/more)**	**Chi-square p-value**
14	30	53.3	415	48.4	1.1	0.60
16	37	56.8	408	48.0	1.2	0.31
18	52	55.8	393	47.8	1.2	0.28
20	62	53.2	383	48.0	1.1	0.45
22	79	51.9	366	48.1	1.1	0.54
24	96	53.1	349	47.6	1.1	0.33
26	113	52.2	332	47.6	1.1	0.40
28	133	51.9	312	47.4	1.1	0.39
Push-ups performance level (# completed) n=445	**N below performance level (less)**	**% with time-loss injury (less)**	**N above performance level (more)**	**% with time-loss injury (more)**	**Risk ratio (less/more)**	**Chi-square p-value**
2	36	50.0	409	48.7	1.0	0.88
4	64	51.6	381	48.3	1.1	0.63
6	108	45.4	337	49.9	0.9	0.42
8	144	47.9	301	49.2	1.0	0.81
10	176	48.3	269	49.1	1.0	0.87
12	214	50.0	231	47.6	1.1	0.62
14	254	52.0	191	44.5	1.2	0.12
16	294	50.0	151	46.4	1.1	0.47
18	328	50.3	117	44.4	1.1	0.28

*Entry-level fitness as measured by the first diagnostic APFT.

Table 15. Physical characteristics of trainees who completed an uninterrupted BCT cycle

Characteristic	Men		Women	
	n	Mean(SD)	n	Mean (SD)
Age (years)	585	19.9(3.1)	389	20.4(4.0)
Stature (cm)	581	176.2(7.3)	390	163.6(6.6)
Body mass (kg)	582	74.1(13.1)	390	61.1(9.5)
Body mass index (kg/m^2)	581	23.8(3.7)	390	22.8(3.1)

SD=standard deviation

Table 16. Demographic characteristics of trainees who completed an uninterrupted BCT cycle

Characteristic		Men		Women	
		n	Proportion (%)	n	Proportion (%)
Race	White	341	58.3	154	39.5
	Black	148	25.3	165	42.3
	Other	78	13.3	65	16.7
	Unknown	22	3.1	6	1.3
Rank	E-1	388	67.1	220	58.7
	E-2	102	17.6	86	22.9
	E-3	70	12.1	49	13.1
	E-4	18	3.1	20	5.3
Component	Regular Army	397	67.9	251	64.4
	Army Reserve	76	13.0	75	19.2
	National Guard	109	18.6	59	15.1
	Unknown	3	0.5	5	1.3

Table 17. First diagnostic APFT* results of trainees who completed an uninterrupted BCT cycle

APFT event	Men		Women	
	n	Mean (SD)	n	Mean (SD)
2-mile run time (minutes)	529	16.7(2.4)	364	21.3(3.1)
Push-ups completed in 2 minutes (n)	563	34(13)	368	13(9)
Sit-ups completed in 2 minutes (n)	562	43(13)	368	37(15)

*This APFT was taken at the reception station.

(2) Univariate analysis revealed that run time, any injury, and time-loss injury were associated with completion of BCT in 9 weeks for both men and women (Tables 18 and 19). The relationship between graduation incidence and two-mile run time is shown graphically in Appendix D. Push-ups and sit-ups on the first diagnostic APFT were also associated with completion of BCT for women.

Table 18. Association of completion of an uninterrupted BCT cycle with first diagnostic APFT results and injury, men

Variable	Categories	N	Completed BCT in 9 weeks(%)	Chi-square p-value/p-value for trend
First diagnostic 2-Mile Run	<15.00 mins	143	96.5	0.03/0.02
	15.01-16.67	140	93.6	
	16.68-18.29	141	95.7	
	>18.30	141	88.7	
First diagnostic Sit-ups	<34 reps	151	89.4	0.17/0.06
	34-42	152	93.4	
	43-51	151	95.4	
	>51	149	94.6	
First diagnostic Push-ups	<25 reps	150	89.3	0.12/0.02
	25-32	158	93.0	
	33-42	147	94.6	
	>42	149	96.0	
Any injury during BCT	Yes	196	78.6	0.00
	No	459	93.9	
Time-loss injury during BCT	Yes	130	71.5	0.00
	No	525	93.7	

Table 19. Association of completion of an uninterrupted BCT cycle with first diagnostic APFT results and injury, women

Variable	Categories	N	Completed BCT in 9 weeks (%)	Chi-square p-value/p-value for trend
First diagnostic 2-Mile Run	<19.34 mins	107	90.7	0.01/0.00
	19.34-21.25	110	86.4	
	21.26-23.63	108	80.6	
	>23.63	108	75.0	
First diagnostic Sit-ups	<26 reps	113	71.7	0.00/0.00
	26-35	111	82.9	
	36-46	116	87.1	
	>46	105	89.5	
First diagnostic Push-ups	<6 reps	108	74.1	0.01/0.00
	6-12	119	80.7	
	13-17	101	85.1	
	>17	117	90.6	
Any injury during BCT	Yes	325	74.2	0.00
	No	173	86.1	
Time-loss injury during BCT	Yes	255	67.8	0.00
	No	243	89.3	

(3) Results of the logistic regression indicated that run time on the diagnostic APFT was the only independent predictor of on-time graduation for men (Table 20). The relationship between run time and completion of BCT was inverse; all other things being equal, for every 1-minute increase in run time, the odds of completing BCT in 9 weeks were reduced by approximately 20% (range: 10-30%). For women, the strongest independent predictor of completion of BCT was time-loss injury during BCT (Table 21). Female trainees who did not suffer a time-loss injury during BCT were nearly four times more likely to complete BCT in 9 weeks than female trainees who sustained a time-loss injury. Age, sit-ups, and run time also remained in the model, but were not strong predictors of on-time graduation. Those who were older, performed fewer sit-ups and ran slower were less likely to graduate on time.

Table 20. Adjusted odds ratios and 90% confidence intervals (CI) for variable associated with completion of an uninterrupted BCT cycle, men

Variable	p-value for Wald statistic	Odds ratio	90% CI
Run time (minutes) on first diagnostic APFT	0.000	0.8	0.7, 0.9

Table 21. Adjusted odds ratios and 90% confidence intervals (CI) for variables associated with completion of an uninterrupted BCT cycle, women

Variable	p-value for Wald statistic	Odds ratio	90% CI
Time-loss injury during BCT	0.00	3.9	2.4, 6.5
Age (years)	0.03	1.1	1.0, 1.2
Sit-ups (repetitions) on first diagnostic APFT	0.03	1.02	1.00, 1.03
Run time (minutes) on first diagnostic APFT	0.06	0.9	0.9, 1.0

(4) The 'cutpoint analysis' showed that, among the male basic trainees (Table 22), BCT completion incidences were higher among the more aerobically fit men from the 14- to 22-minute performance level cutpoints (with the exception of the 16-minute level). No relationship between sit-up performance and BCT completion was demonstrated for men. From 8 to 26 repetitions, men who performed more push-ups during the first diagnostic APFT were more likely to complete BCT on time than men who performed less push-ups. Among the female basic trainees (Table 23), at every 2-mile run performance level from 19- to 26-minutes, faster women were more likely to complete BCT in 9 weeks as compared to slower women. There were no notable trends for female push-ups and sit-ups, since the differences in injury incidence were statistically significant at nearly every performance level.

Table 22. Entry-level fitness* and completion of an uninterrupted BCT cycle†: A comparison of trainees above and below selected APFT performance levels, men

2-mile run time performance level (minutes) n=565	N above performance level (slower)	% completing BCT in 9 weeks (slower)	N below performance level (faster)	% completing BCT in 9 weeks (faster)	Ratio of BCT completion, faster/slower (90% CI)	Chi-square p-value
22	16	56.3	549	94.7	1.68 (1.32,2.05)	0.00
21	32	75.0	533	94.7	1.26 (1.09,1.43)	0.00
20	56	82.1	509	94.9	1.16 (1.05,1.26)	0.00
19	105	89.5	460	94.6	1.06 (1.00,1.11)	0.06
18	171	88.9	394	95.7	1.08 (1.03,1.12)	0.00
17	255	91.8	310	95.2	1.04 (1.00,1.07)	0.10
16	336	92.3	229	95.6	1.04 (1.00,1.07)	0.11
15	422	92.7	143	96.5	1.04 (1.01,1.08)	0.10
14	500	93.0	64	98.5	1.06 (1.03,1.09)	0.09
13	543	93.4	22	100	1.07 (1.05,1.09)	0.21
12	561	93.6	4	100	1.07 (0.97,1.03)	0.60
Sit-ups performance level (# completed) n=603	**N below performance level (less)**	**% completing BCT in 9 weeks (less)**	**N above performance level (more)**	**% completing BCT in 9 weeks (more)**	**Ratio of BCT completion, more/less (90% CI)**	**Chi-square p-value**
14	7	100	596	93.1	0.93 (0.91,0.95)	0.47
16	11	81.8	592	93.4	1.14 (0.91,1.38)	0.13
18	12	83.3	591	93.4	1.12 (0.91,1.33)	0.17
20	17	88.2	586	93.3	1.06 (0.91,1.20)	0.41
22	31	87.1	572	93.5	1.07 (0.96,1.19)	0.17
24	43	90.7	560	93.4	1.03 (0.95,1.11)	0.50
26	54	92.6	549	93.3	1.01 (0.94,1.07)	0.85
28	68	89.7	535	93.6	1.04 (0.97,1.11)	0.22
30	84	89.3	519	93.8	1.05 (0.99,1.12)	0.12
32	116	89.7	487	94.0	1.05 (0.99,1.10)	0.09
34	141	89.4	462	94.4	1.06 (1.00,1.11)	0.04
36	175	89.1	428	94.9	1.06 (1.02,1.11)	0.01
38	216	90.7	387	94.6	1.04 (1.00,1.08)	0.07
40	245	90.6	358	95.0	1.05 (1.01,1.09)	0.04
42	283	91.9	320	94.4	1.03 (0.98,1.07)	0.22
44	320	91.6	283	95.1	1.04 (1.00,1.07)	0.09
46	359	91.9	244	95.1	1.03 (1.00,1.07)	0.13
48	393	92.4	210	94.8	1.03 (0.99,1.06)	0.27
50	420	92.6	183	94.5	1.02 (0.98,1.06)	0.39

*Entry-level fitness as measured by the first diagnostic APFT.

†Uninterrupted BCT cycle = 9 continuous weeks of basic combat training.

Table 22, continued. Entry-level fitness* and completion of an uninterrupted BCT cycle†: A comparison of trainees above and below selected APFT performance levels, men

Push-ups performance level (# completed) n=604	N below performance level (less)	% completing BCT in 9 weeks (less)	N above performance level (more)	% completing BCT in 9 weeks (more)	Ratio of BCT completion, more/less (90% CI)	Chi-square p-value
8	15	73.3	589	93.7	1.28 (1.02,1.53)	0.00
10	19	78.9	585	93.7	1.19 (0.99,1.38)	0.01
12	26	80.8	578	93.8	1.16 (1.00,1.38)	0.01
14	36	83.3	568	93.8	1.13 (1.00,1.25)	0.02
16	54	85.2	550	94.0	1.10 (1.01,1.20)	0.01
18	68	86.8	536	94.0	1.08 (1.00,1.16)	0.03
20	87	87.4	487	94.2	1.08 (1.01,1.15)	0.02
22	115	87.0	489	94.7	1.09 (1.03,1.15)	0.00
24	139	88.5	465	94.6	1.07 (1.02,1.12)	0.01
26	169	89.9	435	94.5	1.05 (1.00,1.10)	0.05
28	194	91.2	410	94.1	1.03 (0.99,1.07)	0.18
30	225	92.0	379	93.9	1.02 (0.98,1.06)	0.36

*Entry-level fitness as measured by the first diagnostic APFT.
†Uninterrupted BCT cycle = 9 continuous weeks of basic combat training.

Table 23. Entry-level fitness* and completion of an uninterrupted BCT cycle†: A comparison of trainees above and below selected APFT performance levels, women

2-mile run time performance level (minutes) n=438	N above performance level (slower)	% completing BCT in 9 weeks (slower)	N below performance level (faster)	% completing BCT in 9 weeks (faster)	Ratio of BCT completion, faster/slower (90% CI)	Chi-square p-value
26	33	66.7	405	84.4	1.27 (1.06,1.47)	0.01
25	53	71.7	385	84.7	1.18 (1.03,1.33)	0.02
24	88	75.0	350	85.1	1.13 (1.03,1.24)	0.02
23	129	76.0	309	86.1	1.13 (1.04,1.22)	0.01
22	176	77.8	262	86.6	1.11 (1.04,1.19)	0.02
21	233	77.7	205	89.3	1.15 (1.08,1.22)	0.00
20	287	80.1	151	88.7	1.11 (1.04,1.18)	0.02
19	336	81.0	102	90.2	1.11 (1.05,1.18)	0.03
18	377	82.2	61	88.5	1.08 (0.99,1.16)	0.22
17	408	82.8	30	86.7	1.05 (0.92,1.17)	0.59
16	422	82.9	16	87.5	1.06 (0.90,1.21)	0.63
Sit-ups performance level (# completed) (n=445)	**N below performance level (less)**	**% completing BCT in 9 weeks (less)**	**N above performance level (more)**	**% completing BCT in 9 weeks (more)**	**Ratio of BCT completion, more/less (90% CI)**	**Chi-square p-value**
14	30	66.7	415	83.9	1.26 (1.04,1.47)	0.02
16	37	67.6	408	84.1	1.24 (1.05,1.43)	0.01
18	52	71.2	393	84.2	1.18 (1.03,1.33)	0.02
20	62	72.6	383	84.3	1.16 (1.03,1.30)	0.02
22	79	72.2	366	85.0	1.18 (1.06,1.30)	0.01
24	96	71.9	349	85.7	1.19 (1.08,1.30)	0.00
26	113	71.7	332	86.4	1.21 (1.10,1.30)	0.00
28	133	72.2	312	87.2	1.21 (1.11,1.30)	0.00
30	158	74.7	287	87.1	1.17 (1.08,1.25)	0.00
32	179	74.9	266	88.0	1.17 (1.09,1.26)	0.00
34	205	76.6	240	87.9	1.15 (1.07,1.22)	0.00
36	224	77.2	221	88.2	1.14 (1.07,1.21)	0.00
38	249	79.1	196	87.2	1.10 (1.03,1.17)	0.02
40	269	79.6	176	87.5	1.10 (1.03,1.17)	0.03
42	290	80.7	155	86.5	1.07 (1.00,1.14)	0.13
44	310	80.3	135	88.1	1.10 (1.03,1.17)	0.05
46	330	80.9	115	87.8	1.09 (1.01,1.16)	0.09
48	346	80.9	99	88.9	1.10 (1.03,1.17)	0.07
50	362	80.9	83	90.4	1.12 (1.04,1.19)	0.04

*Entry-level fitness as measured by the first diagnostic APFT.

†Uninterrupted BCT cycle = 9 continuous weeks of basic combat training.

Table 23, continued. Entry-level fitness* and completion of an uninterrupted BCT cycle†: A comparison of trainees above and below selected APFT performance levels, women

Push-ups performance level (# completed) n=445	N below performance level (less)	% completing BCT in 9 weeks (less)	N above performance level (more)	% completing BCT in 9 weeks (more)	Ratio of BCT completion, more/less (90% CI)	Chi-square p-value
2	36	69.4	409	83.9	1.21 (1.02,1.39)	0.03
4	64	71.9	381	84.5	1.18 (1.04,1.31)	0.01
6	108	74.1	337	85.5	1.15 (1.05,1.25)	0.01
8	144	75.7	301	86.0	1.14 (1.05,1.22)	0.01
10	176	76.7	269	86.6	1.13 (1.05,1.21)	0.01
12	214	77.6	231	87.4	1.13 (1.05,1.20)	0.01
14	254	77.2	191	90.1	1.17 (1.10,1.24)	0.00
16	294	78.9	151	90.1	1.14 (1.07,1.21)	0.00
18	328	79.9	117	90.6	1.13 (1.07,1.20)	0.01
20	359	81.1	86	89.5	1.10 (1.03,1.18)	0.06
22	384	81.3	61	91.8	1.13 (1.06,1.20)	0.04
24	400	81.8	45	91.1	1.11 (1.03,1.20)	0.12
26	409	81.7	36	94.4	1.16 (1.08,1.23)	0.05
28	416	82.0	29	93.1	1.14 (1.04,1.23)	0.13
30	422	82.0	23	95.7	1.17 (1.08,1.25)	0.09

*Entry-level fitness as measured by the first diagnostic APFT.

†Uninterrupted BCT cycle = 9 continuous weeks of basic combat training.

7. DISCUSSION.

a. Entry-level Fitness and Injury During BCT.

(1) The primary purpose of this study was to define the relationship between entry-level fitness and injury in a population of basic trainees. This study population differs from some previous studies of fitness and injury among basic trainees in three ways. First, shortly before this study, the BCT cycle was lengthened from 8 weeks to 9 weeks. Despite this difference, the injury risk ratios and injury incidences for men and women were still within the range of values reported in past investigations. [1-6,9] Second, BCT is currently gender-integrated, whereas studies completed prior to 1995 are of gender-segregated BCT. Third, for this study, the least-fit trainees were not sent to the FTC to improve their fitness prior to entering BCT as had been done since 1985 at Fort Jackson. Rather, the least-fit recruits went directly on to a basic training battalion (2-28th), where they followed the same training schedule and were subjected to the same rigors of BCT as their more-fit peers. This design offered a unique opportunity to observe a sample of recruits receiving the same training that represented the entire range of fitness levels among incoming recruits, thereby enabling the investigators to test a wider range of fitness levels and determine associations with injury. Previous studies that did not capture these least-fit trainees most likely underestimated the effects of low fitness on injury risk.

(2) Although the relationships between APFT performance and injury were not as strong as expected in this study, especially for men, the results generally support what has been established by past research. Women were twice as likely as men to sustain any injury during BCT, 2.6 times as likely to sustain a time-loss injury, and over four times as likely to sustain an injury severe enough to result in a transfer to the PTRP. The 2-mile run time was associated with any injury and time-loss injury among women and trends were similar among men. Women in the slowest run time quartile had a 40% greater chance of sustaining any injury and a 50% greater chance of sustaining a time-loss injury than women in the fastest quartile. Injury incidence trends for both men and women show increasing injury incidence with increasing (slower) run times, suggesting that trainees who are less aerobically fit are more likely to be injured in BCT.

(3) Though this study did not measure VO_2max, the 'gold standard' measure of aerobic capacity, it is possible to predict VO_2max from 2-mile run times using gender-specific linear regression equations. [19] A 2-mile run time of 17 minutes produces a VO_2max of 43 ml/kg*min for both men and women, using these equations. Interestingly, two investigations of infantry soldiers [20,21] found that the lowest individual VO_2max values were 44 and 45 ml/kg*min. BCT involves acquiring skills in infantry tasks. These data may suggest not only that a minimal VO_2max of at least 43 ml/kg*min will result in lower injury rates, but that a VO_2 max near this value may be the minimum required to succeed in infantry operations. Some caution must be

exercised with regard to this interpretation since the VO_2max values are predicted verses actual, and only a total of 116 subjects were involved in the two infantry studies. However, further research to test a minimum aerobic fitness level that minimizes injuries and result in acceptable performance could proceed from this point.

(4) Further evaluation of the relationship between entry-level fitness and injury during BCT using a 'cutpoint analysis' indicated that, in general, injury incidence was lower among those with faster 2-mile run times. However, for some performance measures, it was observed that after a particular performance level was reached, there was little additional reduction in injury risk with increases in performance. Specifically, for both men and women, those trainees with two-mile run times less than 17 minutes showed little difference in injury risk when compared to those with run times of 17 minutes or more. For men, risk of any injury and time-loss injury also plateaued at performance levels of 10 and 11 push-ups, respectively. Performance above these levels resulted in little change in injury risk. Risk of any injury plateaued at the performance level of 26 sit-ups for men as well. There was no level of push-up or sit-up performance at which injury risk plateaued for women. Based on these results, it is possible to suggest that BCT entry-level fitness criteria for men should be based on run time, push-ups, and sit-ups, but criteria for women should be based only on run performance.

b. Entry-level Fitness and Completion of an Uninterrupted BCT Cycle.

(1) In the current study, run time played a role in on-time completion of BCT among both men and women. For women, time-loss injury was an important predictor of on-time BCT graduation. Female trainees who did not sustain a time-loss injury were almost four times more likely than their injured peers to graduate on time. These results suggest that higher entry-level fitness and injury prevention may play important roles in reducing attrition and recycling rates in BCT.

(2) The 'cutpoint analysis' revealed trends in BCT completion ratios for three APFT events. This analysis suggested that those men who achieved run times of at least 14 minutes or performed at least 26 push-ups experienced similar graduation rates compared to men who performed at higher levels. In addition, women who ran the first diagnostic APFT in at least 19 minutes had similar graduation incidence compared to their more fit counterparts. Of these three events, only run time for men was determined to be an independent predictor of on-time graduation, suggesting that the criterion for male run time may be important when attempting to predict graduation.

(3) These results were only suggestive of a relationship between entry-level aerobic fitness and on-time graduation from BCT. Successful completion of training is most likely determined by many other factors not measured in this study. Since the primary focus of this

study was injuries and our data was limited to APFT and medical records, we did not measure other predictors of graduation. Other predictors include smoking status, self-reported prior physical activity, [15] and psychological characteristics. [16-18]

8. CONCLUSIONS AND RECOMMENDATIONS.

a. The primary purpose of this study of basic trainees at Fort Jackson was to determine the relationship between injuries and entry-level physical fitness in basic training and to define a minimum first diagnostic APFT performance level for entry into basic training based on injury risk. The data suggest that there may be APFT performance levels at which further improvements in performance do not result in reductions of injury risk. The following performance levels represent thresholds below which injury risk is higher and above which there is minimal change in injury risk:

(1) For men and women, a 2-mile run time of 17 minutes on the first diagnostic APFT. This is the most important criterion to establish since past research consistently links slow run time with increased injury risk.

(2) For men only, completion of 26 sit-ups on the first diagnostic APFT.

(3) For men only, completion of 10 push-ups on the first diagnostic APFT.

b. A secondary purpose of this report was to assess the relationships between entry-level fitness, injury, and completion of an uninterrupted nine-week BCT cycle. The most significant finding was the relationship of two-mile run time for men and time-loss injury for women with completion of training in nine weeks. Further research is needed to validate the suggested APFT performance criteria and to assess other, potentially stronger predictors of on-time graduation.

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APPENDIX A

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APPENDIX B

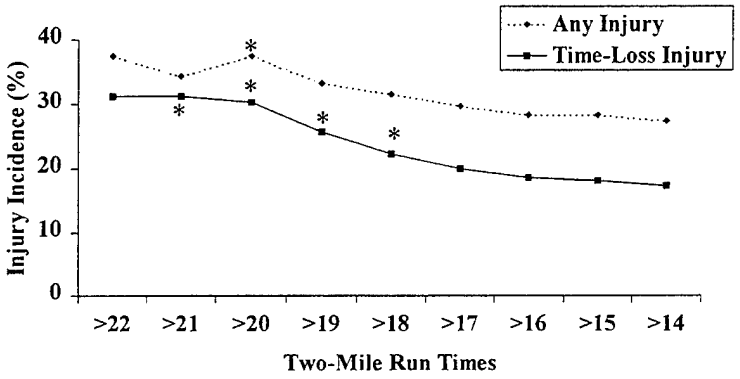
BASIC COMBAT TRAINING GRADUATION REQUIREMENTS FORT JACKSON, DECEMBER 1998

Satisfactory participation in or completion of the following training requirements was necessary in order to graduate from Basic Combat Training at Fort Jackson:

1. Tactical road marches (7)
2. Bayonet assault course (includes pugil stick training)
3. Conditioning obstacle course
4. Hand-to-hand (unarmed) combat training
5. Confidence obstacle course
6. Team development course
7. Nuclear, biological, chemical (NBC) defense training
8. Hand grenade qualification
9. M16 rifle marksmanship qualification
10. Army physical fitness test (score = 150 points)[19]
11. Victory Tower
12. Buddy team live fire course
13. Night infiltration course
14. Victory Forge (3-day field training exercise)
15. Individual Proficiency Test (end-of-phase test of common soldiering skills)
16. Pass inspection
17. Demonstrate discipline, motivation, and adherence to Army standards and code of conduct
18. Demonstrate an understanding of and willingness to live by the Army's seven core values

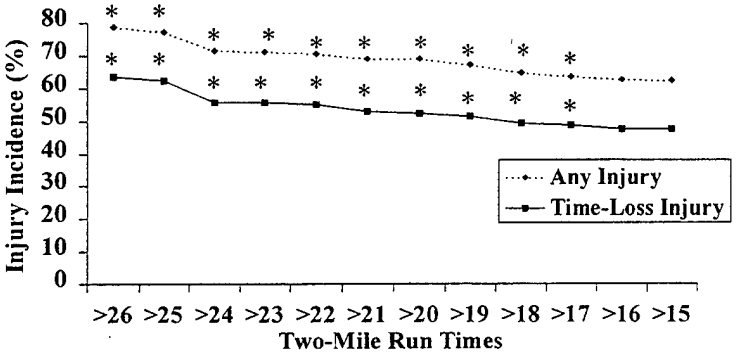
APPENDIX C

Association of Diagnostic 2-Mile Run With Injuries in BCT



N=604 Men (Ft Jackson, Fall 1998)

* Statistically significant ($p<0.10$) difference between % injured above and below two-mile run time cutpoint

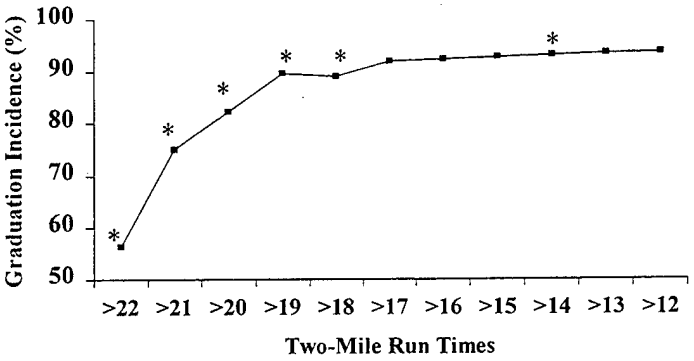


N=445 Women (Ft Jackson, Fall 1998)

* Statistically significant ($p<0.10$) difference between % injured above and below two-mile run time cutpoint

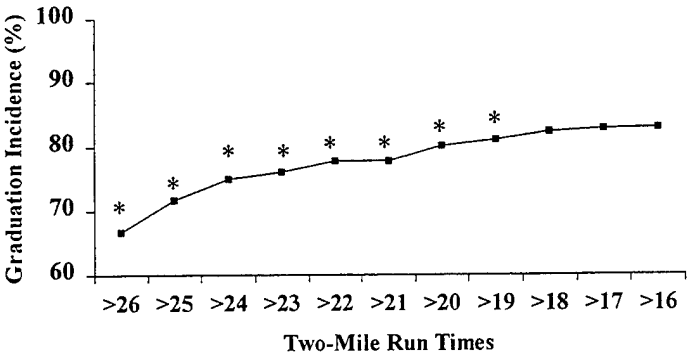
APPENDIX D

Association of Diagnostic 2-Mile Run With Graduation from BCT



N=604 Men (Ft Jackson, Fall 1998)

* Statistically significant ($p<0.10$) difference between % graduated above and below two-mile run time cutpoint



N=445 Women (Ft Jackson, Fall 1998)

* Statistically significant ($p<0.10$) difference between % graduated above and below two-mile run time cutpoint

APPENDIX E

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