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# Assessment of Recruit Motivation and Strength Study: Preaccession Physical Fitness Assessment Predicts Early Attrition

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**ABSTRACT** Background: The Assessment of Recruit Motivation and Strength (ARMS) study was designed to pilot-test the use of a physical fitness screening tool for Army applicants before basic training. Methods: The ARMS test consists of two components, namely, a 5-minute step test and push-ups. Attrition among 7,612 recruits who underwent preaccession ARMS testing and began service between May 2004 and December 2005 was studied. Results: ARMS test performance was found to be significantly related to risk of attrition within 180 days; the hazard ratios for failing relative to passing the ARMS test were 2.27 (95% confidence interval, 1.70–3.04) among female subjects and 1.36 (95% confidence interval, 1.13–1.64) among male subjects. The attributable risk of attrition associated with failing the ARMS test was ~40% among female subjects and ~30% among male subjects. Discussion: The ARMS study is the first prospective study conducted in the U.S. Army to assess physical fitness before accession. Physical fitness and motivation to serve were shown to correlate with attrition during initial entry training.

## INTRODUCTION

Approximately 250,000 enlisted applicants are examined for fitness at military entrance processing stations (MEPSs) each year, with ~160,000 entering the service.[1] Despite extensive screening processes, including criminal background checks, aptitude tests,[2] medical examinations, and weight-for-height standards,[3] nearly 6,000 recruits per year receive discharges because of medical conditions existing prior to service (EPTS) within 6 months and another 10,000 are prematurely discharged for a variety of reasons, including failure to pass a minimum physical fitness test.[4–6]

Premature discharge of new enlistees has a significant impact on U.S. military expenditures and readiness. In recent years, attrition during the first 12 weeks of service among active duty Army enlistees has been as high as 15%. The associated fiscal year 2005 cost is estimated to be $31,000 per lost recruit. Given a recruiting target of 80,000 active duty Army enlistees for fiscal year 2006, the cost of replacing and training 10% of recruits is more than $450 million per year.[7,8]

Research conducted in the U.S. military and foreign militaries has demonstrated associations between premilitary service fitness levels and risks of training-related injuries and attrition among new recruits in processing at reception battalions.[9–13] Unlike other physically demanding professions, such as firefighting, steel working, coal mining, and military service in many other countries,[14,15] the U.S. Army does not currently screen applicants for physical fitness before enlistment. Physical assessment is currently performed for U.S. military academy and Marine Corps applicants.

Another factor that is likely related to success in basic combat training and beyond is an individual's motivation to succeed. Research has shown that willingness to participate in sports and exercises is correlated with task completion, ego, and motivation.[16,17] Unfortunately, there is no tri-service-validated measure to assess, in an operational setting, motivation to serve in the military.[18–20]

The National Research Council Committee on the Youth Population and Military Recruitment recently reviewed the research in this area, reporting that poor physical fitness is a strong risk factor for injury and an even stronger risk factor for attrition.[21] They specifically recommended study of pre-basic training fitness interventions as a potentially viable and cost-effective approach to reducing injury and attrition rates. This may be critical to the future success of basic combat training, because the physical fitness of both recruits and general U.S. adolescents and young adults has declined over the past decade, and recruit height, weight, and body mass index (BMI) have progressively increased over the past two decades.[22] Millions of dollars could potentially be saved if unfit and unmotivated individuals were identified at application, rather than in the service.

The Assessment of Recruit Motivation and Strength (ARMS) study was designed to pilot-test the use of simple preaccession fitness performance tests to identify individuals who lack the physical fitness and/or motivation required to complete basic combat training. In an attempt to quickly assess baseline physical fitness in an operational setting and motivation to complete

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physically rigorous activity, the ARMS test consists of two dichotomous (pass/fail) components, namely, a modified Harvard step test (a measure of fitness and motivation)[23,24] and push-ups (a measure of muscular endurance).

## METHODS

### Overall Study Design

A prospective study of ARMS testing as a screening tool for fitness was conducted at six MEPS locations (Atlanta, Georgia; Buffalo, New York; Chicago, Illinois; Sacramento, California; San Antonio, Texas; and San Diego, California), beginning in February 2004. These MEPSs were approved by U.S. Military Entrance Processing Command to give a reasonable geographic and demographic representation of the total of 65 MEPSs. The first 3 months of the study consisted of implementation of the ARMS test and standardization of procedures at the six sites.

Active duty Army applicants were required to complete the two components of the ARMS test by order of the commander of U.S. Army Accession Command.[25] As a precaution, the Physical Activity Readiness Questionnaire[26] was used to assess the capability and readiness of applicants to take the test. All applicants who reported any contraindication to physical testing and all applicants who thought that they could not participate were excluded from testing. Performance or nonperformance of these physical tests was not reported to the examining physicians or screening personnel. Research assistants assured applicants that their performance would not affect their ability to enlist in the Army. Before performing the ARMS tests, applicants were asked to enroll in the ARMS research study and gave formal written consent for researchers to monitor them for attrition and morbidity outcomes throughout their first term of enlistment, which ranged from 3 to 5 years. This project was approved as a minimal-risk study by the institutional review board at the Walter Reed Army Institute of Research.

### ARMS Test Components

*Step Test*

The step test used in this study was a modified Harvard step test, which was originally developed at the Harvard Fatigue Laboratory in 1943.[23] Dynamic physical fitness is scored on the basis of the length of time an individual is able to endure the test, to a maximum of 5 minutes, and the recovery heart rate. The original assessment of postexercise heart rate was determined from three measurements; however, a single measurement at 1 minute after exercise produced results in good accordance with the original method.[27] This step test has been widely evaluated in the literature and is generally considered a good indicator of overall physical fitness.[28–30] For large-scale screening and research purposes, the test allows for low-risk, noninvasive, relatively quick determinations of dynamic physical fitness and potential assessments of motivation level.

To complete the step test, subjects were instructed to step up and down on a 21-inch $\times$ 27-inch, nonskid, adjustable, step-up box set to a height of 12 inches for female subjects and 16 inches for male subjects, based on the physiological gender differences in aerobic metabolism. The stepping pace was kept at 120 beats per minute with a metronome, with a step being defined as a complete cycle of stepping up (both feet on the platform) and stepping down (both feet back on the floor). Therefore, 120 beats per minute was equivalent to 30 steps per minute. Subjects performed the step test for 5 minutes or until failure or inability to continue at the proper pace. Sixty seconds after completion of the test, each subject noted his or her heart rate by using an electronic wrist monitor or manual detection. The passing criterion for the step test was set at completion of the full 5 minutes at the correct pace.

*Push-ups*

Upper body muscular endurance was tested through completion of as many push-ups as possible in a 1-minute period. Although no passing criteria were specifically mentioned to study subjects, male and female subjects who completed at least 15 and 4 push-ups, respectively, were considered to have passed this portion of the ARMS test. The thresholds of 15 push-ups for male subjects and 4 push-ups for female subjects were selected after the first 3 months of the pilot study, to keep the pass percentages consistent according to gender and to guarantee large enrollments without high attrition risk in this prospective study.

### Study Subjects

The subjects in the study consisted of all U.S. Army recruits who took the ARMS test at any of the six study sites and were subsequently shipped to basic training. Only applicants who were $\geq$18 years of age at the time of ARMS testing and who signed the informed consent form to allow follow-up monitoring and outcome analysis are described. The present study reports on applicants who took both the step and push-up components of the ARMS test and enlisted on active duty between May 1, 2004, and December 31, 2005.

### Outcomes and Factors

This study examined whether Army enlistees who were fit and motivated to pass the ARMS test had lower likelihood of early attrition than did enlistees who did not pass. The endpoint for this analysis was attrition from military service for any reason during the first 180 days of service. All-cause attrition was used as the outcome because motivation and physical fitness, the two factors targeted by the ARMS test, are thought to play a role in most or all categories of attrition.

Performance (pass or fail) on the ARMS test was the key prediction variable analyzed relative to attrition. This dichotomous test outcome was used in favor of other, more complex, potential outcomes, such as the raw results on the two individual ARMS components, because of operational constraints. Other variables considered included known risk factors for early attrition, age, gender, race, education, and year of accession.

### Data Sources

Data on ARMS test performance parameters were collected by using a Microsoft Access (Microsoft, Redmond, Washington) data collection form designed for the study. Information related to medical history, past hospitalizations, disqualifications, consultations, and waivers were collected from standard medical forms (forms DD2807 and DD2808) generated at the MEPS as part of the standard enlistment application process. Attrition data on study subjects were obtained from the Center for Accession Research, U.S. Army Recruiting Command (Fort Knox, Kentucky). These data included information regarding military accession and discharge dates and reasons for discharge, where appropriate.

### Statistical Analyses

The Cox proportional-hazards (CPH) model was used to quantify the likelihood of surviving on active duty. CPH models use the hazard ratio (HR) to describe the relationship between survivorship and predictors. If the HR of two groups is equal to 1, then the two groups have the same survival distributions. If the HR is equal to 2, then one group has a much higher attrition rate (approximately double, if the attrition rate is not too high) than the other at a given time, and the differences increase as the time increases. The general form of the CPH model is $h(t) = h_0(t)\exp(\beta_1 X_1 + \cdots + \beta_p X_p + \epsilon)$, where $h(t)$ is the hazard at time $t$ for the combination of predictors $X_1$ to $X_p$ and $h_0(t)$ is the baseline hazard.[31]

In this study, categorical analysis was used to examine the study population and related ARMS pass rates. CPH models were applied to assess the relationship between ARMS test performance and likelihood of attrition, controlling for the effects of other attrition-associated factors.

The assumption underlying CPH modeling, that is, that the effect of a predictor factor on hazard remains constant over time, was assessed by applying the time-dependent model and estimation of the hazard function. The model was restricted to 3-month time periods up to 12 months of service. Attrition HRs associated with passing or failing the ARMS test were then compared. Results of this modeling were used to generate predicted retention probability curves based on populations by gender with the same demographic distributions as study subjects.

The CPH modeling results were also used to generate estimates of risk of attrition over time attributable to failing the ARMS test. This measure can be interpreted as the percentage of attrition among all study subjects and demographically similar individuals attributable to failing the ARMS test that would not have occurred if they had passed. Analyses were performed by using SAS 9.3 (SAS Institute, Cary, North Carolina).

## RESULTS

There were 9,196 individuals who took both components of the ARMS test in May 2004 to December 2005, of whom

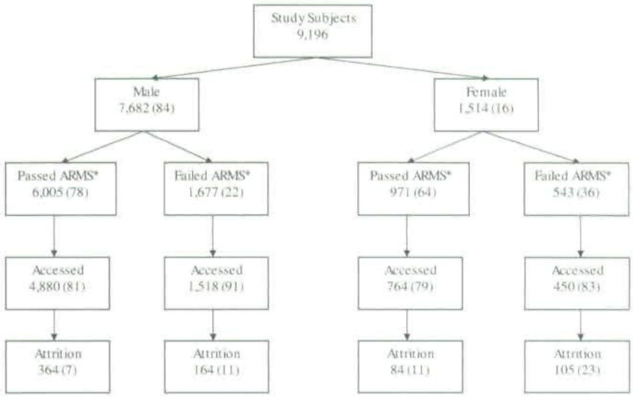


**FIGURE 1.** ARMS study population according to numbers of subjects and percentages. *Passed ARMS, passed both the step test and push-up components of the ARMS test; failed ARMS, failed the step test and/or push-up components of the ARMS test.

7,612 subsequently accessed into active duty enlisted service during the same time period (Fig. 1). Of those individuals, 84% were male and 16% were female. The ARMS test (step test and push-ups) pass percentage was higher for male subjects (78%) than for female subjects (64%; $p < 0.01$). Overall, 81% of subjects who passed the ARMS test and 89% of subjects who did not pass were accessed into active duty. The overall unadjusted relative risks of attrition were 1.45 (95% confidence interval [CI], 1.22–1.73) for male subjects and 2.12 (95% CI, 1.63–2.76) for female subjects. These estimates included all study subjects who accessed during the study period, with variable follow-up periods.

Table I summarizes the demographic characteristics of the subjects who took the ARMS test. The age distributions of male and female subjects were quite similar, with >90% being ≤25 years of age. A larger proportion of female subjects were African American (28.2%), compared with male subjects (13.8%). BMI at the time of the initial visit to the MEPS did not necessarily reflect status at accession. Almost 75% of female subjects had BMI values in the normal range according to National Institutes of Health (NIH) guidelines, compared with ~53% of male subjects. Accordingly, greater percentages of male subjects had BMI values in the overweight and obese categories (35.5% and 8.5%, respectively), compared with female subjects (20.6% and 0.7%, respectively).

Table II shows the results of ARMS testing according to component and overall. It is apparent that the step test generally presented the greater challenge. Only 67% of female subjects and 80% of male subjects passed this component. Pass percentages for the push-up component were well over 90% among both male subjects and female subjects. Although these high pass percentages somewhat limited the potential effect of the push-up test in predicting attrition, informal analyses indicated that applicants who failed the push-up test were at significantly greater risk of attrition than were those who passed (relative risk, 2.45 for male subjects and 3.12 for female subjects; $p < 0.01$ for both; results not shown). In addition, attrition modeling with the full ARMS

**TABLE I.** Demographic Characteristics of the Study Population

| Characteristic | Proportion (%) Male ($N$ = 7,682) | Female ($N$ = 1,514) |
|---|---|---|
| Age (years) | | |
| 18–20 | 61.6 | 63.8 |
| 21–25 | 29.5 | 27.7 |
| 26–30 | 6.8 | 5.7 |
| >30 | 2.1 | 2.8 |
| Missing ($n$ = 23) | | |
| Race | | |
| Caucasian | 80.8 | 64.9 |
| African American | 13.8 | 28.2 |
| Other | 5.4 | 6.9 |
| Missing ($n$ = 1,646) | | |
| Ethnicity | | |
| Hispanic | 47.2 | 50.0 |
| Non-Hispanic | 52.8 | 50.0 |
| Other | 0.1 | |
| Missing ($n$ = 4,957) | | |
| BMI | | |
| Underweight, <18.5 kg/m$^2$ | 3.0 | 4.4 |
| Normal weight, 18.5–24.9 kg/m$^2$ | 53.1 | 74.3 |
| Overweight, 25–29.9 kg/m$^2$ | 35.5 | 20.6 |
| Obese, >30 kg/m$^2$ | 8.5 | 0.7 |
| Missing ($n$ = 133) | | |
| Tobacco history | | |
| Yes | 24.8 | 18.2 |
| No | 75.2 | 81.8 |
| Missing ($n$ = 536) | | |

**TABLE II.** ARMS Performance According to Test Component

| Test Components | Pass Rate (%) Male | Female |
|---|---|---|
| Step test | 80 | 67 |
| Push-ups | 97 | 93 |
| Step test and push-ups | 78 | 64 |

All differences between male and female subjects were statistically significant ($p < 0.01$, $\chi^2$ test).

test (step test and push-up test combined) showed better model fit than did modeling with the step test alone. The likelihood ratio test with and without the push-up test showed that the contribution of the push-up test was significant ($p < 0.01$). Accordingly, the push-up test was retained as a criterion for passing the ARMS test.

Table III shows the personnel classification reasons for loss among subjects who were accessed and subsequently discharged before completion of their first term of service. Army regulations mandate that each discharge be assigned a single code characterizing the reason for loss. The reasons for loss were sorted according to the numbers of losses among those who passed the ARMS test. Among female subjects who passed the ARMS test and accessed, discharges because of EPTS medical conditions were the most prevalent (7.8%). However, among those who failed the ARMS test, entry-level performance and conduct represented the leading reason for discharge (9.3%). Among male subjects, EPTS conditions represented the leading reason for discharge among both those who passed the ARMS test and those who failed. It should be noted, however, that discharge percentages for performance and conduct were higher among male subjects who failed the ARMS test than among those who passed. Although this latter separation category is used for a wide range of issues, one is Army Physical Fitness Test failure in initial entry training. It is not known how many discharges were related to Army Physical Fitness Test failure.

**TABLE III.** Reasons for Loss during the First 6 Months of Service

| | No. (%) Passed ARMS Test | Failed ARMS Test |
|---|---|---|
| Female[a] | | |
| EPTS, failure to meet procurement medical fitness standards | 34 (4.5) | 35 (7.8) |
| Entry-level separation, performance and conduct | 21 (2.8) | 42 (9.3) |
| Physical condition, not disability | 14 (1.8) | 12 (2.7) |
| All other | 15 (2.0) | 16 (3.6) |
| Total | 84 | 105 |
| Male[b] | | |
| EPTS, failure to meet procurement medical fitness standards | 157 (3.2) | 75 (4.9) |
| Entry-level separation, performance and conduct | 106 (2.2) | 44 (2.9) |
| Physical condition, not disability | 57 (1.2) | 21 (1.4) |
| All other | 44 (0.9) | 24 (1.6) |
| Total | 364 | 164 |

Proportions are of total subjects in the relevant category who accessed onto active duty.

[a] Comparing distribution of losses, $p > 0.19$.

[b] Comparing distribution of losses, $p > 0.78$.

In a review of ~65% of all EPTS discharge records available, it was found that asthma, mood disorders, and personality disorders were the most commonly cited medical conditions. This was true for male subjects and female subjects, regardless of whether they passed or failed the ARMS test. Musculoskeletal conditions, including pes planus, pain in the lower extremities, and back pain, were the next most common reasons for EPTS discharge, although the numbers were small (<10 in all subject groups).

Before accounting for other attrition-related factors in a CPH model, the assumptions underlying the model were examined. Table IV shows HRs characterizing the risk of attrition among those who failed the ARMS test, relative to those who passed, at different time intervals, with no other factors included in the model. It can be seen that the HR estimates remained relatively stable over the first 180 days of service. Moreover, when using the nonproportional-hazards model, we found that the time effect of ARMS testing on the likelihood of attrition was not significant ($p > 0.39$), which

**TABLE IV.** HRs for Attrition According to Length of Service (Failed ARMS Test versus Passed ARMS Test)

| Time in Service (days) | HR (95% CI) | |
|---|---|---|
| | Female | Male |
| 60 | 2.19 (1.39–3.45) | 1.65 (1.24–2.21) |
| 90 | 2.39 (1.66–3.44) | 1.53 (1.21–1.94) |
| 120 | 2.37 (1.72–3.27) | 1.46 (1.18–1.80) |
| 180 | 2.27 (1.70–3.04) | 1.36 (1.13–1.64) |
| 270 | 1.94 (1.49–2.53) | 1.38 (1.17–1.62) |
| 365 | 1.91 (1.49–2.44) | 1.34 (1.15–1.57) |

indicates that the proportional-hazards assumption is reasonable for early attrition. The effect of ARMS test performance on attrition likelihood seemed to diminish over longer follow-up periods. This is expected, because poor physical fitness or lack of motivation likely would manifest during the 9-week rigors of basic training. On the basis of the observed results, it was concluded that the proportional-hazards assumption is valid up to 180 days of service, and the full model was generated accordingly.

Table V shows the results of CPH attrition modeling among female subjects. ARMS test performance was found to be sig-

**TABLE V.** HRs for Attrition Within 180 Days of Service

| Factor | Parameter Estimate | SE | HR (95% CI) | $p$ Value |
|---|---|---|---|---|
| Female | | | | |
| ARMS test | | | | |
| Pass (reference group) | 0.00 | | 1.00 | |
| Fail | 0.82 | 0.15 | 2.27 (1.70–3.04) | <0.01 |
| Age (years) | | | | |
| 18–20 (reference group) | 0.00 | | 1.00 | |
| 21–25 | 0.13 | 0.16 | 1.14 (0.83–1.58) | 0.41 |
| 26–30 | −0.14 | 0.33 | 0.87 (0.45–1.67) | 0.67 |
| >30 | 0.46 | 0.35 | 1.58 (0.79–3.16) | 0.19 |
| Race/ethnicity | | | | |
| Non-Hispanic Caucasian (reference group) | 0.00 | | 1.00 | |
| Hispanic Caucasian | −0.16 | 0.22 | 0.85 (0.55–1.31) | 0.46 |
| African American | −0.43 | 0.22 | 0.65 (0.43–1.00) | 0.05 |
| Other | −0.04 | 0.32 | 0.96 (0.52–1.78) | 0.90 |
| Missing data | −0.02 | 0.20 | 0.98 (0.67–1.44) | 0.92 |
| BMI | | | | |
| Underweight | 0.35 | 0.33 | 1.43 (0.75–2.72) | 0.28 |
| Normal weight (reference group) | 0.00 | | 1.00 | |
| Overweight | −0.26 | 0.19 | 0.77 (0.53–1.13) | 0.18 |
| Obesity | −0.03 | 0.72 | 0.97 (0.24–3.99) | 0.97 |
| Tobacco history | | | | |
| Yes | 0.21 | 0.18 | 1.24 (0.87–1.75) | 0.23 |
| No (reference group) | 0.00 | | 1.00 | |
| Male | | | | |
| ARMS test | | | | |
| Pass (reference group) | 0.00 | | 1.00 | |
| Fail | 0.31 | 0.09 | 1.36 (1.13–1.64) | <0.01 |
| Age (years) | | | | |
| 18–20 (reference group) | 0.00 | | 1.00 | |
| 21–25 | 0.13 | 0.09 | 1.14 (0.95–1.37) | 0.15 |
| 26–30 | 0.07 | 0.17 | 1.07 (0.77–1.48) | 0.67 |
| >30 | 0.22 | 0.27 | 1.25 (0.73–2.14) | 0.42 |
| Race/ethnicity | | | | |
| Non-Hispanic Caucasian (reference group) | 0.00 | | 1.00 | |
| Hispanic Caucasian | −0.33 | 0.13 | 0.72 (0.55–0.94) | 0.01 |
| African American | −0.10 | 0.14 | 0.91 (0.69–1.20) | 0.49 |
| Other | 0.15 | 0.19 | 1.16 (0.80–1.68) | 0.44 |
| Missing | −0.11 | 0.12 | 0.90 (0.71–1.13) | 0.36 |
| BMI | | | | |
| Underweight | 0.73 | 0.20 | 2.08 (1.40–3.09) | <0.01 |
| Normal weight (reference group) | 0.00 | | 1.00 | |
| Overweight | 0.22 | 0.09 | 1.25 (1.04–1.50) | 0.02 |
| Obesity | 0.17 | 0.15 | 1.19 (0.88–1.60) | 0.26 |
| Tobacco history | | | | |
| Yes | 0.31 | 0.09 | 1.36 (1.13–1.63) | <0.01 |
| No (reference group) | 0.00 | | 1.00 | |

The results are based on multivariate proportional-hazards models.

nificantly related to the likelihood of attrition, with the estimated HR for failing relative to passing the ARMS test being 2.27 (95% CI, 1.70–3.04). None of the other factors included in the model showed significantly elevated hazards, relative to the respective baseline groups. The estimated HR for female subjects who were underweight according to NIH guidelines was fairly large but statistically insignificant (HR, 1.43; $p = 0.28$), whereas the estimated HRs for the overweight and obese categories were below unity. African American female subjects had a borderline significantly low HR, relative to non-Hispanic, Caucasian, female subjects (HR, 0.65; $p = 0.05$).

Table V also shows analogous results for male subjects. As with female subjects, it can be seen that attrition hazard was significantly greater among those who failed the ARMS test than among those who passed, although the magnitude of the effect was smaller (HR, 1.36; 95% CI, 1.13–1.64). It also can be seen that male subjects who were underweight according to NIH guidelines had significantly elevated attrition hazard (HR, 2.08; $p < 0.01$), as did overweight male subjects. The HR for male subjects who were obese was greater than unity but not significantly elevated, because the number of individuals in this category was small. Male subjects with a history of tobacco use were also found to be at elevated risk for attrition (HR, 1.36; $p < 0.01$), relative to male subjects who had not used tobacco.

Figures 2 and 3 show predicted retention probability curves for the study subjects who passed and those who did not pass the ARMS test. It can be seen that, for both male subjects and female subjects, retention patterns over the first 180 days of service were significantly different ($p < 0.01$ for both comparisons). It was estimated that ~20% of female subjects who failed the ARMS test would be discharged within 180 days of service, compared with ~13% of female subjects who passed the ARMS test. Among male subjects, ~14% of those who failed the ARMS test would be discharged within 180 days, compared with ~10% of those who passed the ARMS test.

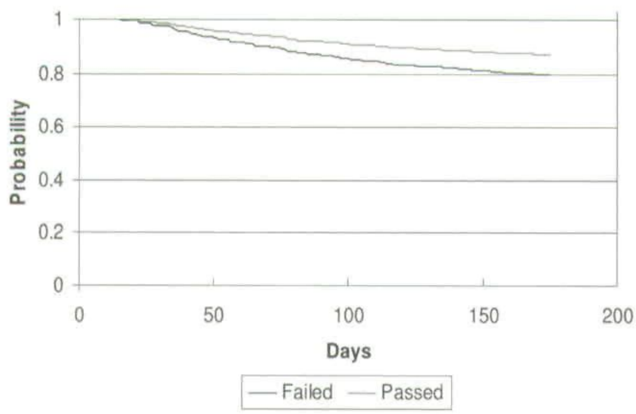


**FIGURE 2.** Retention probability during the first 180 days of service, according to ARMS test performance, for female subjects. Results are based on previous CPH models, with an overall significant HR for the ARMS test ($p < 0.01$).

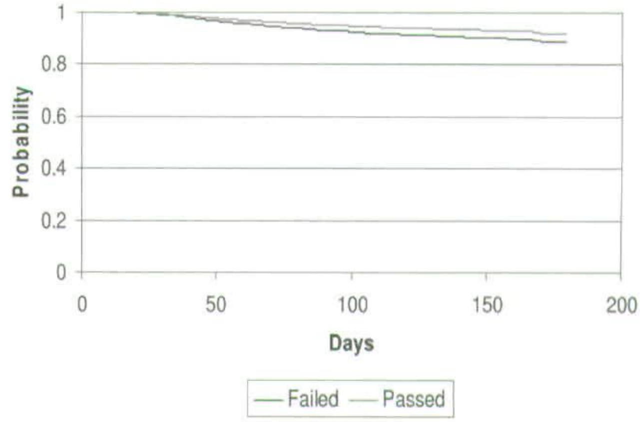


**FIGURE 3.** Retention probability during the first 180 days of service, according to ARMS test performance, for male subjects. Results are based on previous proportional-hazards models, with an overall significant HR for the ARMS test ($p < 0.01$).

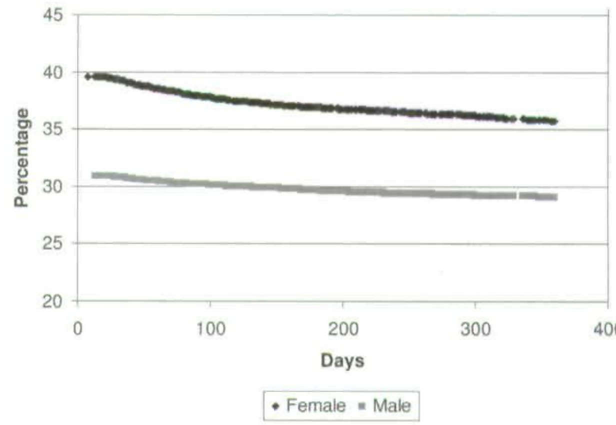


**FIGURE 4.** Risk of attrition over time attributable to failing the ARMS test.

Figure 4 shows estimates of the risk of attrition over time, up to 365 days of service, attributable to failing the ARMS test, from the CPH model. It can be seen that, during the first month of service, almost 30% of attrition among male subjects who failed the ARMS test was estimated to be in excess of that expected in a population that is able to pass the ARMS test. Among female subjects, the attributable risk of attrition related to ARMS failure was just over 40% during the first month of service. For both male subjects and female subjects, the attributable risk associated with ARMS test failure declined slightly over time in service, as other factors became more important in affecting retention likelihood.

## DISCUSSION

The ARMS study administered a two-component physical fitness test to >9,100 Army applicants at six MEPSs. The overall pass rate for the push-up and step tests was 76%, and the rate was higher for male subjects than for female subjects. Of those who subsequently began active duty service, all-cause attrition rates during the first 180 days of service were higher among those who failed the ARMS test, compared with those who passed, for both male subjects and female subjects. The majority of these discharges were for EPTS medical conditions and entry-level performance conditions, including physical fitness test failures.

The significant relationship between ARMS test performance and likelihood of attrition remained after controlling for other known risk factors. The elevation in risk of attrition was significant among both male subjects and female subjects who failed the ARMS test, relative to their counterparts who passed. Although the effects of the other risk factors did not generally achieve statistical significance, the directionality of their estimated effects was consistent with other studies.[1] Specifically, positive but nonsignificant increases in attrition risk were associated with being older, being Caucasian, being underweight, and having a smoking history. Being underweight, overweight, or obese increased risk among male subjects, whereas being overweight or obese had a negative but nonsignificant effect on attrition among female subjects.

One limitation of this study is that assessing ARMS test performance involves some subjectivity with regard to whether proper pace was maintained in the step test. Although anecdotal information and observations suggested that subject preparation varied considerably across the study sites, the wide range of pass percentages among sites (60.9–97.4%) suggests that subjectivity played a role. However, analysis of retention probabilities according to gender for the three highest-pass rate versus three lowest-pass rate MEPSs showed no statistical difference.[1]

Another limitation is that the lack of specificity in Army discharge codes limits the usefulness of analyses according to categories of attrition. Total attrition was used as the primary endpoint for this study because fitness and motivation are hypothesized to have potential roles in most or all types of discharges. Ideally, specific categories of attrition related to test performance would be examined. For example, the leading cause of attrition in this study was "EPTS, failure to meet medical procurement standards." Although the Accession Medical Standards Analysis and Research Activity has the most complete databases on such discharges, only two thirds of these discharges actually appeared in the Accession Medical Standards Analysis and Research Activity database. In addition, a study of discharges at Fort Leonard Wood indicated that categorization codes often insufficiently characterize the underlying reasons for discharge, particularly with respect to medical and psychological factors.[32]

Finally, the six selected MEPSs did not represent a random cluster sampling; therefore, it is possible that the applicants selected for this study are not representative of the entire applicant population. Because of the nonrandomness of the site selection, we checked the representativeness of the six ARMS study MEPSs, with respect to the other 59 MEPSs. We examined overall 180-day attrition rates and found that the rate among active duty applicants who were processed through these six sites during 2004 and 2005 was quite similar to that for applicants processed through the remaining 59 sites (Wilcoxon rank test, $p > 0.35$). We also examined the BMI effect on 180-day attrition rates and found that the HRs for BMI of >25 kg/m$^2$ versus <25 kg/m$^2$ were 1.12 among the selected sites and 1.15 among the 59 other sites, which were not significant ($p = 0.70$). Therefore, no differences were found between the selected sites and the other 59 sites, in terms of overall or BMI-associated attrition rates. Moreover, the comparisons in this study are of the effects of fitness and motivation among applicants, and those effects are expected to be similar across MEPS sites, even if crude attrition rates differ.

The ARMS study is the first prospective study conducted in the U.S. Army to assess physical fitness before accession with longitudinal follow-up monitoring of accessions for outcomes in military service. A number of studies related to ARMS testing are in progress through the study subjects' initial enlistment period. A study is being conducted of ARMS test performance as a predictor of morbidity, which has been found to be increased in subjects with poor fitness.[33] U.S. Army Accession Command has funded a study of a waiver program of the maximal allowable accession body fat standards (up to 30% for male subjects and 35% for female subjects) with demonstrated physical fitness, as measured with the ARMS test.

Physical fitness and the motivation to serve, as measured with the ARMS test, have been shown to be associated with attrition in initial entry training. This offers the potential to reduce morbidity and attrition as a future accession standard in times of an abundant recruiting pool for the all-volunteer force. Alternatively, in times of a limited recruiting pool, demonstrated physical fitness may be studied as a waiver criterion for selected prevalent disqualifications, such as weight and body fat standards.

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## REFERENCES

1. Walter Reed Army Institute of Research: Accession Medical Standards Analysis and Research Activity 2005 Annual Report. Silver Spring, MD, Walter Reed Army Institute of Research, 2006.
2. About the ASVAB. Available at http://www.military.com/ASVAB; accessed February 5, 2008.
3. Department of the Army: Army Regulation 40-501: Standards of Medical Fitness, 2006. Washington, DC, Department of the Army, 2006.
4. Cigrang JA, Carbone EG, Todd S, Fiedler E: Mental health attrition from Air Force basic military training. Milit Med 1998; 163: 834–8.
5. Niebuhr DW, Powers TE, Li Y, Millikan AM: Morbidity and attrition related to medical conditions in recruits. In: Recruit Medicine (Textbooks of Military Medicine), pp 59–79. Edited by DeKoning BL. Washington, DC, Department of the Army, Office of the Surgeon General, 2003.

6. Talcott GW, Haddock CK, Klesges RC, Lando H, Fiedler E: Prevalence and predictors of discharge in United States Air Force basic military training. Milit Med 1999; 164: 269–74.
7. Department of the Army: Initial Entry Training, Unit and Overall Attrition Trends. Washington, DC, Department of the Army, Military Personnel Management, 2006.
8. Thomas J: Information Paper: Cost of a New Recruit for FY 2005. Fort Monroe, VA, U.S. Army Training and Doctrine Command, 2006.
9. Kaufman KR, Brodine S, Shaffer R: Military training-related injuries: surveillance, research, and prevention. Am J Prev Med 2000; 18(Suppl 3): 54–63.
10. Knapik JJ, Darakjy S, Hauret KG, et al: Increasing the physical fitness of low-fit recruits before basic combat training: an evaluation of fitness, injuries, and training outcomes. Milit Med 2006; 171: 45–54.
11. Knapik JJ, Hauret KG, Lange JL, Jovag B: Retention in service of recruits assigned to the Army Physical Fitness Test Enhancement Program in basic combat training. Milit Med 2003; 168: 490–2.
12. Knapik JJ, Scott SJ, Sharp MA, et al: The basis for prescribed ability group run speeds and distances in U.S. Army basic combat training. Milit Med 2006; 171: 669–77.
13. Pope RP, Herbert R, Kirwan JD, Graham BJ: Predicting attrition in basic military training. Milit Med 1999; 164: 710–4.
14. Allsopp AJ, Scarpello EG, Andrews S, Pethybridge RJ: Survival of the fittest? The scientific basis for the Royal Navy pre-joining fitness test. J R Nav Med Serv 2003; 89: 11–8.
15. Jackson AS: Preemployment physical evaluation. Exerc Sport Sci Rev 1994; 22: 53–90.
16. Duda JL: Relationship between task and ego orientation and the perceived purpose of sport among high school athletes. J Sport Exerc Psychol 1989; 11: 318–35.
17. Elsass WP, Wingler IM: Psychological aspects of sports in children and adolescents. In: DeLee & Drez's Orthopaedic Sports Medicine: Principles and Practice, Ed 2, Vol 2, pp 687–702. Edited by DeLee J, Drez D, Miller MD. Philadelphia, PA, Saunders, 2003.
18. McCraw RK, Bearden DL: Motivational and demographic factors in failure to adapt to the military. Milit Med 1988; 153: 325–8.
19. McCraw RK, Bearden DL: Personality factors in failure to adapt to the military. Milit Med 1990; 155: 127–30.
20. Young MC, White LA: Preliminary operational findings from the Army's Tier Two Attrition Screen (TTAS) measure. Presented at the 25th Army Science Conference, 2006, Orlando, FL.
21. National Research Council: Assessing Fitness for Military Enlistment: Physical, Medical, and Mental Health Standards. Washington, DC, National Academies Press, November 27–30, 2006.
22. Knapik JJ, Sharp MA, Darakjy S, Jones SB, Hauret KG, Jones BH: Temporal changes in the physical fitness of U.S. Army recruits. Sports Med 2006; 36: 613–34.
23. Brouha GA, Graybiel A, Heath C: The step test: a simple method of measuring physical fitness for hard muscular work in adult men. Rev Can Biol 1943; 2: 86–91.
24. Sloan AW: The Harvard step test of dynamic fitness. Triangle 1962; 5: 358–63.
25. U.S. Army Training and Doctrine Command: Memorandum, January 22, 2004: Assessment of Recruit Motivation and Strength Research Project. Fort Monroe, VA, U.S. Army Training and Doctrine Command, 2004.
26. Thomas S, Reading J, Shephard RJ: Revision of the Physical Activity Readiness Questionnaire (PAR-Q). Can J Sport Sci 1992; 17: 338–45.
27. Montoye HJ: The Harvard step test and work capacity. Rev Can Biol 1953; 11: 491–9.
28. Banerjee PK, Chatterjee S: Harvard step test as a measure of physical fitness in adolescent boys. Indian J Med Res 1984; 79: 413–7.
29. Keen EN, Sloan AW: Observations on the Harvard step test. J Appl Physiol 1958; 13: 241–3.
30. Sloan AW: A modified Harvard step test for women. J Appl Physiol 1959; 14: 985–6.
31. Hosmer DW, Lemeshow S: Applied Survival Analysis: Regression Modeling of Time to Event Data. New York, NY, Wiley, 1999.
32. Niebuhr DW, Powers TE, Krauss MR, Cuda A, Johnson K: A review of initial entry training discharges at Fort Leonard Wood, MO, for accuracy of discharge classification type: fiscal year 2003. Milit Med 2006; 171: 1142–6.
33. Knapik JJ, Canham-Chervak M, Hauret K, Hoedebecke E, Laurin MJ, Cuthie J: Discharges during U.S. Army basic training: injury rates and risk factors. Milit Med 2001; 166: 641–7.