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Predicting Attrition in Basic Military Training

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This cohort study investigated whether the risk of attrition during Australian Army recruit training was predicted by the fitness, age, date of enlistment, or injury status of recruits. Subjects were 1,317 male Australian Army recruits undertaking 12 weeks of intensive training. Fitness was measured using a 20-m progressive shuttle run test (20 mSRT) in which higher scores reflected higher fitness. A total of 184 subjects failed to complete training. Two hundred seventy-six disabling lower limb training injuries were recorded; 100 were stress fractures or periostitis. Scores on the 20 mSRT ranged between 3.5 and 13.5. Multivariate survival analysis revealed a strong negative association between 20 mSRT score and risk of attrition ($p < 0.001$) and a positive association between sustaining a lower limb injury and risk of attrition ($p < 0.001$). These effects were additive. Age and enlistment date were not significantly associated with risk of attrition. Fitness and training procedures may be important, modifiable risk factors for attrition.

Introduction

Basic military training places physical and psychological pressures on recruits.[1,2] Recruits can fail to complete training for a range of reasons, including lack of medical fitness (injury or illness), self-requested discharge, and poor psychological suitability.[2] This results in costs to military establishments that can amount to thousands of dollars for each recruit who fails to complete training. Such costs include initial recruitment, transport to the training establishment, uniforms and equipment, accommodation and rations, wages, instruction and supervision, administration, and medical, dental, and psychological care.

Military establishments generally screen potential enlistees to determine their suitability in terms of psychological aptitude and medical fitness. Individuals at high risk of attrition or failure in their specific vocation are denied enlistment. The psychological suitability of applicants is assessed primarily using paper-and-pencil tests.[3] The emphasis in such tests is usually on determining a measure of general intelligence,[4,5] which has been shown to correlate significantly and positively with various measures of training success, including completion of basic military training.[1,2,5] Factors such as coping skills, defense mechanisms, and motivational attributes are also important[2] and can be similarly tested. Typical medical screening in both military situations and civilian sports is nonfunctional. The individual responds to a battery of questions regarding past or present injury or illness, and tests or observations are performed on the passive candidate in an attempt to exclude major illness or structural deficits.[3,6-8] Even if candidates pass this screening process, it provides little information regarding their aerobic fitness and functional ability. The screening does not directly test the applicant's ability to perform and maintain an adequate level of physical work under conditions of physical and psychological stress.[8,9] This information is probably less important for vocations involving sedentary work, but military life often demands considerable physical and psychological robustness of the individual. Studies in both civilian and military populations have indicated that in physically demanding vocations, various functional measures of strength and physical fitness predict performance.[1,3,9,10]

Some institutions already use functional testing procedures to assess the suitability of candidates for specific jobs. Fleishman[3] lists examples from the United States, including firefighters, police, dock workers, mechanics, telephone line workers, and others. Such testing may include a formal assessment of work capacity in which an individual is required to actively demonstrate the strength, coordination, skill, or endurance required to safely perform a job.[3] It may also include limited exposure to simulated work conditions to enable assessment of coping skills, motivation, perceptual-motor skills, and physical attributes of the individual relative to job requirements.[3] However, these types of functional assessments can be costly and time-consuming to administer, especially for large numbers of applicants. For this reason, more passive screening options are frequently used. Simple functional tests that strongly and reliably predict the success or failure of applicants in achieving the required work output and persevering with the job are a desirable addition to screening procedures.

Chin et al.[11] investigated the value of two functional screening tests in U.S. Air Force recruits. Relationships between success in completing basic military training and the result of submaximal cycle ergometry and 2-mile run times were examined. No significant association was found for either test, but the authors noted that both tests probably failed to test the recruits' motivation, e.g., by pushing them to achieve a certain predetermined standard. They recommended that future research examine the usefulness of a fitness test with predetermined pass criteria in predicting success or failure in basic military training. Burke et al.[1] investigated the role that a general intelligence score and 2-mile run time might play in predicting training success in infantry recruits. Success was measured in terms of results achieved on a final performance test rather than simple com-

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pletion of the program. Using this measure, both the general intelligence score and the 2-mile run time were significant, additive predictors of success.

The primary aim of this prospective cohort study was to determine the value of a simple, maximal fitness test, the 20-m progressive shuttle run test (20 mSRT),[12] in predicting the success or failure of Australian Army recruits in training. The 20 mSRT has been shown to be a valid and reliable indicator of aerobic fitness and running ability[13–15] and is a useful predictor of relative injury risk for recruits in basic military training.[16] From a sample of 1,317 recruits, Pope et al.[16] reported that recruits who scored 6 or less on the 20 mSRT (low fitness) were five times more likely to sustain injury than recruits who scored 11 or more (high fitness). Moreover, the 20 mSRT is readily conducted with minimal staffing, tests many participants simultaneously, requires only 15 to 20 minutes to complete, and can be conducted in a relatively small, weatherproof setting such as an indoor gymnasium or basketball court. In Australia, the test was used by Army physical training instructors to test the fitness of recruits for some time before this study.

A multivariate approach was used to determine the predictive value of the 20 mSRT for attrition while controlling for possible confounding factors, including age, time of year at enlistment, and injuries incurred during training. It was expected that injury would increase the risk of attrition by direct effect (a recruit being deemed medically unfit because of injury) or indirect effect (for example, by placing a strain on the individual's coping capacity).[17] Unpublished data from Australian Army recruit training indicates a significantly increased rate of attrition among recruits enlisting after the first 3 months of each calendar year. The reasons for this are not clear, but it was hoped that a multivariate analysis of the results of this cohort study might shed some light on this issue. Age has been implicated in affecting success in completing military training,[2] so age was also included for investigation.

A secondary aim of this study was to examine the value of the 20 mSRT score as a prognostic indicator in the event of lower limb injury. In particular, it would be useful to be able to predict the likelihood of injured recruits successfully completing basic training within a reasonable time (defined as 6 months by the Australian Army, based on a 12-week basic training program). Injured recruits who are unlikely to complete basic training within a reasonable time, or who are likely to request discharge from the army before completion of training, might benefit from interventions designed to increase completion rates and reduce attrition. Alternatively, perhaps they should be discharged from the military sooner to reduce costs and comply with duty of care.

Methods

Subjects

The cohort for this study consisted of 1,317 male Australian Army recruits who were a subsample of participants in a 1994 randomized, controlled trial[16] of the prophylactic benefits of preexercise stretching on injury risk. The recruits were aged 17 to 35 years and undertook the intensive and regimented 12-week basic training program of the Australian Army at Kapooka, in rural New South Wales. All recruits who enlisted during the study period were included in the cohort providing that they gave informed, voluntary consent for participation and were tested on the 20 mSRT before commencing training. Of 1,538 recruits who gave informed consent to participate (from a potential pool of 1,589 eligible subjects), 20 mSRT results were obtained for 1,317 recruits, who then formed the cohort for this study. Enlistment was progressive, and subject enrollment occurred from January 1994 to November 1994. All procedures were approved by the Australian Defence Medical Ethics Committee and by the Ethics Committee of Charles Sturt University. All subjects, by the time they were enlisted, had passed an extensive battery of medical and psychological tests aimed at ensuring suitability for training.

Procedures

Before commencing training at Kapooka, recruits underwent an initial fitness assessment. This assessment was conducted routinely for all recruits commencing training, and not especially for this study. The assessment included the 20 mSRT[12] and occurred at Kapooka just after arrival. The 20 mSRT protocol has been well documented.[12] Briefly, subjects are required to run back and forth between two lines marked on the ground, which are spaced 20 m apart. The speed of running is controlled by standardized auditory cues (beeps) from a commercially available[12] audiocassette tape played from a cassette player. The commencing speed of running is 8.5 km/h; this increases by 0.5 km/h at approximately 1-minute intervals, which are labeled stage 1, stage 2, and so on. The score achieved by any subject on the test equates to the stage the subject reaches before being unable to keep up with the speed of running then required. Each subject is deemed unable to keep up with the required speed of running once he fails to reach within two strides of the line drawn on the ground twice in a row in accordance with the auditory cues.

Data Collection and Analysis

Lower limb injuries incurred by subjects in the course of training were recorded as described by Pope et al.[16] Injury was defined as any lower limb injury that prevented the subject from resuming full duties, free of signs or symptoms, within 3 days. These injuries were categorized according to type (e.g., stress fracture) and body region (e.g., tibia) by one medical officer who was unaware of 20 mSRT scores recorded for each subject in this study. In cases of tibial injury (stress fracture or periostitis), the injury grade was determined from bone scans by an independent radiologist according to the protocol described by Zwas et al.[18] Information regarding recruit attrition was collected by the discharge clerk for administrative purposes and forwarded to the researchers.

Inferential analysis involved assessing the significance of 20 mSRT score, time of year at enlistment, age, and injury status as predictors of risk of attrition. For this purpose, a multivariate survival analysis was conducted using Cox's proportional hazards model with a backward stepwise analysis.[19] Injury status was analyzed as a time-dependent variable.[19] The statistical significance of the contribution of each variable to the model was determined at each step of the analysis on the basis of a calculated likelihood ratio (LR). The LR indicated the extent to which a variable explained the variability between subjects in risk of attrition.

Spearman rank-order correlation analysis was performed to examine the extent of correlation between 20 mSRT score and grade of tibial shaft injury (stress fracture or periostitis). This relationship was examined to provide some indication of whether fitness affected the severity of injury. Tibial shaft injuries were used for this purpose because of the relatively high number expected and because a well-defined, objective grading protocol has been documented for tibial shaft injuries.[18] Grading of stress fractures was performed by independent radiologists, who were unaware of treatment group and 20 mSRT score. Statistical Package for the Social Sciences computer software was used in all analyses.

Results

Of the 1,317 participating recruits, 184 subjects (14%) failed to complete training and were discharged from the Army. Unpublished Army records show that during the study period, 23% of those recruits who failed to complete training were discharged at their own request, 59% were discharged as "medically unfit," and 18% were discharged as "not suited to be a soldier." If a recruit suffered a lower limb injury, he was discharged as medically unfit only if the regimental medical officer deemed that he could not be fully rehabilitated and returned to active training within a 12-week period from the date of injury. Some injured recruits were also discharged for nonmedical reasons (at their own request or because they were deemed not suited to be a soldier). A total of 276 subjects (21%) suffered a lower limb injury during the course of training, including 100 cases of stress fracture or periostitis. Of these, 66 were stress fractures or periostitis affecting the tibial shaft. Apart from those individuals discharged, another 22 subjects (1.7%) were selected to attend officer training during the middle one-third of the training program, and so withdrew from the study at that time, without lower limb injury.

The final Cox regression model for risk of attrition included only 20 mSRT score (LR = 46.6 for 1 degree of freedom [df]; $p < 0.001$) and injury status (LR = 184.0 for 1 df; $p < 0.001$). Age was not a significant predictor of risk of attrition (LR = 0.08 for 1 df; $p = 0.78$), and neither was time of year at enlistment (LR = 0.04 for 1 df; $p = 0.84$). There was no significant interaction between 20 mSRT and injury status in determining risk of attrition (LR = 0.10 for 1 df; $p = 0.75$), i.e., the risk attributable to these variables was additive.

The distribution of 20 mSRT scores was close to normal, with a score of 8.7 ± 1.6 (mean ± SD). The Cox regression models developed for risk of attrition are graphed in Figure 1 (based on 20 mSRT score), Figure 2 (based on injury status), and Figure 3 (based on both 20 mSRT score and injury status). The model can be expressed as follows:

relative risk of attrition

$$= e^{-0.3228 \times (20\text{ mSRT score} - 8.7) + 2.2941 \times (\text{injury status} - 0.097)}$$

where injured and uninjured cases were assigned injury status values of 1 and 0, respectively. In this equation, the relative risk of attrition (RRA) for any given set of values for the predictor variables (20 mSRT score and injury status) equals the absolute risk of attrition associated with that set of values divided by the absolute risk at the mean of each of the predictor variables.

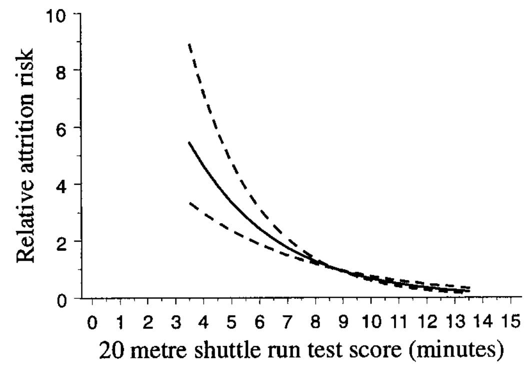

Fig. 1. Cox regression model of 20 mSRT scores versus relative risk of attrition. Ninety-five percent confidence intervals for the population estimates of relative attrition risk are also indicated. The confidence interval converges to 0 when 20 mSRT score = 8.7 because the relative risk for all scores is calculated relative to the risk at the mean score, which is 8.7.

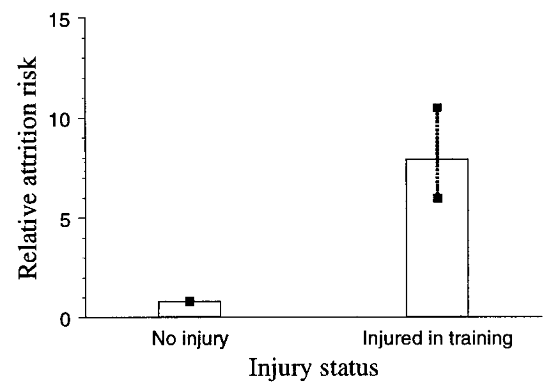

Fig. 2. Cox regression model of injury status versus relative risk of attrition, with 95% confidence intervals. See Figure 1 for details.

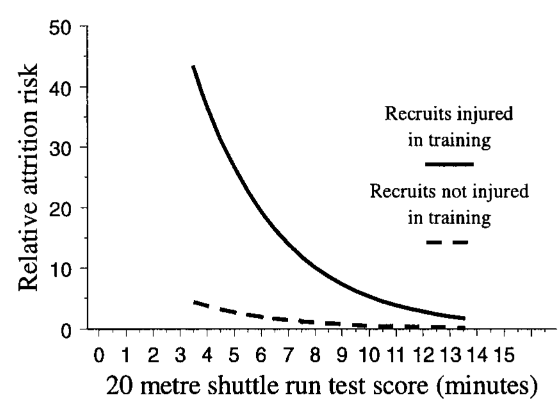

Fig. 3. Cox regression model for risk of attrition incorporating both 20 mSRT score and injury status.

Subjects who had sustained an injury in training were 10 times more likely to fail to complete training than subjects who had not sustained an injury (Fig. 2), because the RRA was 7.9 for injured subjects and 0.80 for noninjured subjects. Similarly, the least fit subjects (20 mSRT score = 3.5; RRA = 5.4) were 25 times more likely to fail to complete training than the fittest subjects (20 mSRT score = 13.5; RRA = 0.22) (Fig. 1). Figure 3 indicates that unfit subjects who sustained injury (RRA = 43.1) were up to 250 times more likely to fail to complete training than fit subjects who were not injured (RRA = 0.17). Furthermore, fit subjects with an injury (RRA = 1.7) were about 25 times more

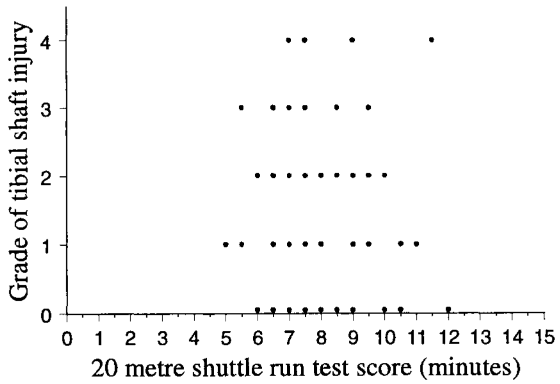

Fig. 4. Scatterplot depicting the relationship between 20 mSRT score and grade of tibial shaft injury sustained. Grade 0 represents periostitis; grades 1 to 4 represent stress fracture grades 1 to 4.[18]

likely to recover from their injury and complete training successfully than less fit subjects with an injury (RRA = 43.1). The calculated Spearman correlation coefficient for the relationship between 20 mSRT score and tibial shaft injury grade (Fig. 4) was not significant ($\rho = -0.073$; $p = 0.56$).

Discussion

The results of this study indicate that 20 mSRT score, measured before commencement of training, is a strong predictor of attrition in basic military training. In both injured and noninjured subjects, recruits who scored poorly were about 25 times more likely to fail to complete training than the fitter recruits who scored highly. Injury in training was also associated with a greatly increased risk of attrition. Some injured recruits were discharged specifically because of injury, but many injured recruits were discharged at some later stage for other reasons, including difficulty coping, reduced motivation to continue, and further injury. Recruits who had sustained a lower limb injury were, on average, 10 times more likely to be discharged than recruits who had not sustained an injury. Injury status and 20 mSRT score were additive in the final predictive model for attrition (Fig. 3).

There was no evidence of a correlation between 20 mSRT score and injury severity in the 66 cases of tibial shaft injury recorded (Fig. 4). It would appear, therefore, that injury severity is not necessarily reduced in recruits of higher fitness, even though fitter recruits were more likely to complete training after incurring an injury. Rather, fitter recruits may simply be better able to recuperate, cope, or persevere after injury than less fit recruits. Further research is required to determine whether this is because of physiological or psychological correlates of the 20 mSRT score. However, because injury tends to reduce efficiency and increase the energy expenditure associated with ambulation,[20] it could be expected that those subjects already struggling to keep up because of poor fitness would be more inclined to give up and drop out if they sustained an injury.

Contrary to perceptions in Australian Army recruit training, time of year at enlistment did not significantly add to the predictive model for attrition. Vickers and Conway[2] found that age was associated with success in completing military training, but the results of this study do not support that finding. It is possible that the narrow range of ages recorded in this study (17–35 years) obscured any such relationship.

Given the high risk of attrition related to injury during recruit training, any strategies that can be shown to reduce injury rates are likely to also reduce rates of attrition. Because many of the injuries recorded in this study were overuse injuries,[16] attention to the work-to-rest ratio and the sequence within the training program is warranted.[21] The Australian Army has addressed this issue since the time of this study, with apparent success in reducing both injury and attrition rates (unpublished Army data).

Because preenlistment 20 mSRT scores can be used to identify recruits "at risk" of attrition both before enlistment and in the event of injury, further research is warranted to determine whether this risk can be modified. Strategies such as fitness training or psychological interventions that target intrinsic motivation and coping skills or seek to modify extrinsic stresses imposed on recruits during training or rehabilitation should be investigated. If attrition risk cannot be readily modified, identified recruits would be best excluded from military service as early as possible to comply with duty of care and to reduce financial loss. Further research is also required to determine the extent to which the 20 mSRT score is additive to currently used psychological variables in a multivariate predictive model for attrition. It is possible that at least some of the predictive value of the 20 mSRT for attrition is related to the psychological, rather than the fitness, correlates of the 20 mSRT score.

Although this study has provided robust evidence of the predictive value of 20 mSRT scores for attrition in basic military training, it must be remembered that 20 mSRT scores also strongly predict risk of lower limb injury,[16] running performance,[15] and maximum aerobic capacity.[13-15] It is evident from the results of this study that 20 mSRT scores predict risk of attrition not only through their propensity to predict lower limb injury[16] (which often precedes attrition) but also in the absence of injury and after an injury has been incurred. Further research is required to determine which fitness, ability, or psychological correlates of the 20 mSRT score are associated with its predictive value for attrition.

Civilian exercise programs are also plagued by attrition of participants, especially when the program seeks to introduce previously inactive participants to exercise.[22,23] Further research to investigate the value of 20 mSRT scores in predicting attrition in civilian programs would be useful. If potential dropouts could be identified, and if psychological or physical interventions were shown to be successful in preventing attrition in those at risk, such programs might be more effective in retaining participants.[23] These concepts are particularly important in programs designed to promote community health and well-being through exercise.[23] Coaches of professional and nonprofessional sports teams are also faced with the task of selecting players who are least likely to give up, suffer injury, or drop out and who will strive hardest for success. The results of this study and of the study by Pope et al.[16] suggest that the 20 mSRT may play a valuable role in the selection process. Further research is necessary to validate this concept.

It is concluded that 20 mSRT scores significantly predict attrition from basic military training. Injury in training also significantly increases the risk of attrition, and the effects of these two factors are additive in predicting attrition in basic military training.

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