The Effect of a Modified Physical Training Program in Reducing Injury and Medical Discharge Rates in Australian Army Recruits

Guarantor: Lt Col Stephen J. Rudzki, Royal Australian Army Medical Corps
Contributors: Lt Col Stephen J. Rudzki, Royal Australian Army Medical Corps*; Michael J. Cunningham, BS†

This uncontrolled observational study examined the injury and medical discharge outcomes in 318 female and 1,634 male recruits as a result of changes to the Australian Army recruit physical training program. Changes included cessation of road runs, introduction of 400- to 800-m interval training, reduction in test run distance from 5 to 2.4 km, standardization of route marches, and the introduction of deep-water running. There was a 46.6% reduction in the rate of total injury presentation (χ² = 14.31, p = 0.0002) after the change. The annual rate of male medical discharges decreased 40.8% from 81.1/1,000 recruits in 1994/1995 to 47.0/1,000 recruits in 1995/1996 (χ² = 26.53, p = 0.0001). Female rates increased 58.3% from 104/1,000 recruits to 164.2/1,000 recruits (χ² = 6.09, p = 0.014). The decrease in the male medical discharge rate resulted in an estimated saving of 81,267,805 Australian. Bone scans were reduced by 50%, resulting in an estimated annual saving of 661,539 Australian. The disparity between male and female injury rates is a concern. The merits of mixed-gender physical training should be reviewed in the light of these observations, and the establishment of initial entry fitness standards for recruit training may need to be considered.

Introduction

High rates of injury have been reported in recruits from a number of different western armies. Reported injury rates were 27.4% in male and 44.6% in female U.S. Army recruits,1 31% in male South African recruits,2 33.5% in male British Marines,3 and 47.2% and 37.9% in two groups of male Australian recruits.4 Most of these injuries were ascribed to physical training.

Women have been noted to have higher morbidity during U.S. Army recruit training. The incidence of stress fracture is higher,5 and the rate of sick call visits for injury in female recruits was found to be twice that of male recruits.6 Limited duty rates for injury were 16 days/100 recruits/month in males and 77 days/100 recruits/month in females. However, several well-designed studies of injury in civilian runners have shown no differences in the rates of injury between men and women.7-9 There would appear to be a disproportionate rate and impact of injury in female U.S. Army recruits.

Most researchers have sought to identify risk factors for injury. Jones et al.1 identified a number of risk factors, including low levels of past activity, low levels of physical fitness, previous history of injury, high running mileage, smoking, and age. Most of these risk factors are intrinsic in nature and could be controlled only by a process of exclusion at the enlistment stage. This would be difficult to justify without high relative risk values and would also reduce the available pool of potential recruits. Running distance has been consistently identified as a major risk for injury in civilian runners8,9 and recently in military recruits.1,4

As a result of previous research findings, l,4 the Commandant of the 1st Recruit Training Battalion (1RTB) directed that the physical training program be completely revised in the belief that reduced injury rates would result. These changes were developed and implemented within 8 weeks. This paper presents a retrospective review of the outcomes of these changes, specifically, the effect on male and female injury and medical discharge rates.

Methods

Study Design

This was a retrospective, uncontrolled observational study comparing the rates of injury and medical discharge before the change in the standard Australian Army physical training (PT) program with the rates after the change.

Platoons that entered the 1st Recruit Training Battalion during financial year 1995/1996 were divided into three groups. The platoons that arrived during the 3-month period from July to September 1995 (N = 708) represented group 1, or the pre-change sample. Group 2 (October 1, 1995, to January 17, 1996 [N = 667]) entered training when the two physical training programs were in concurrent use. Group 3 (January 24, 1996, to May 6, 1996 [N = 579]) commenced training when the new program was universal. It was assumed that the 3-month period before the change was representative of the preexisting training cycle.

This analytical approach was adopted because of a perceived staff need to adapt to the new physical training regimen. Because of the concurrent physical training systems in place, it was felt that there may have been some "lapses" into old ways during the group 2 training.

Calculation of Injury Rates and Data

Presentations to the physiotherapy department were used to calculate injury rates. All recruits were initially assessed by a single medical officer, and any injury requiring sick leave, hospitalization, or 3 days of restricted duty was automatically referred for physiotherapy. The only exception to this was recruits with undisclosed preexisting injuries, who were rapidly discharged for failure to disclose.

Physiotherapy attendance records were reviewed, and individuals were identified by their date of arrival (or group). Al-
though the true incidence of injury was likely to have been higher, the use of physiotherapy attendance was considered representative of more severe injury, because any injury requiring only 3 days of restriction is likely to have been minor.

The number of bone scans ordered by the medical staff was examined as a marker for the clinical suspicion of stress fractures. The same medical officer staffed the Recruit Medical Center during this 9-month period. This medical officer was in her second year at 1RfB and was experienced in the clinical and radiological diagnosis of stress fractures. The number of radionuclide bone scans ordered between July 1995 and March 1996 was retrospectively obtained from the radiology department billing records. The medical officer was unaware that these records were to be examined. The bone scans were divided into those made before and after October 1, 1995.

The rates of medical discharge for the 4-year period from financial year 1992/1993 to 1995/1996 were calculated from the Army Central Personnel Database. The number of medical discharges, by sex, was divided by the number of recruits who commenced training in that year and expressed as a rate. A 4-year period was chosen to place any changes in discharge rates into a historical perspective.

Sample Selection

The total recruit population for 1995/1996 was 3,181: 2,700 males and 481 females. This study examined the outcomes in males and 481 females. This study examined the outcomes in 1,634 males (60.5%) and 318 females (66.1%) of the total population. Informed consent was not obtained because these changes were instigated at the direction of the commanding officer and the observations reported were retrospective.

Training Program

The changes to the standard Australian Army PT program sought to modify three perceived external risk factors: (1) over-training of lower limb structures, (2) running in boots during route marches, and (3) excessive running distance.

The following changes to the PT program were implemented: (1) cessation of road runs as a formed body (with a 26.5-km reduction in running distance); (2) introduction of interval training (400- and 800-m sprints) on grassed surfaces; (3) reduction in running distance; (4) standardization of road marches, with a controlled speed of march, graduated load increments, and the banning of running; and (5) introduction of deep-water running as a cross-training technique.

Physical training instructors were briefed in detail about the changes. Because of initial staff resistance to the changed program, one author (M.J.C.) was required to observe the PT staff to ensure compliance during the initial implementation.

The exit physical fitness standards were not altered, and all recruits in each group had to successfully complete the Australian Army Basic Fitness Assessment (2.4-km run, push-ups, and sit-ups) within the defined age and gender limits for trained soldiers. In addition, all recruits regardless of age and gender had to complete a specific 1RfB test called “The Challenge” (12-km march, obstacle course, bayonet course, and rifle shoot).

Interval Training

All recruits performed a timed 2.4-km run in week 1. Interval training was conducted in eight groups of equivalent ability based on the initial run time; the fastest time was less than 8 minutes and the slowest group took more than 13.5 minutes. This allowed individuals to train at an intensity specific to their ability.

All interval training sessions were conducted on grassed ovals, whereas previously most running had been conducted on asphalt roads. Recruits were required to run 400 and 800 m within times determined from their initial 2.4-km run. The sessions commenced at a distance of 1600 m and graduated to 3200 m.

The 400- and 800-m split times were set at 75% and 80%, respectively, of the 2.4-km run rate. For example, recruits who completed the 2.4-km run in 8 minutes covered 400 m in 1.33 minutes and the 75% 400-m interval training time was set at 1.00 minute.

Deep-Water Running

Deep-water running was implemented to enable aerobic training without impact loading of the lower limbs. Sessions were conducted in platoon groups using the deep-water running technique described by Lucas.11

Platoons were divided into six groups and each group was assigned a swimming pool lane. All recruits wore buoyancy belts, and three levels of water running were performed. A typical lesson involved six sets of repetitions at varying levels, with effort increasing at each level. Deep-water running sessions were deliberately programmed after high-impact activities, e.g., the 12-km route marches.

Route Marches

Anecdotal evidence suggested that many instructors ran their recruits for much of the 8- and 12-km route marches. To prevent this, instructors were given strict time tolerances within which to complete route marches. The completion time was set by the required speed of march, with platoons being allowed a 2-minute variation from the calculated finish time.

March routes were marked out and kilometer and half-kilometer points were posted. This allowed platoon staff to accurately gauge the speed of march, e.g., 6 km/h was equivalent to 10 min/km. Thus, with a march speed of 6 km/h the time required to complete a 12-km route march was 2 hours ± 2 minutes.

Statistics

χ² analysis was performed to establish any significant differences in injury, discharge, and investigation rates before and after the change. Analysis was performed on an Apple Macintosh computer using Statview 512+ software. Statistical significance was set at the 0.05 level.

Results

Rates of Injury

The total rate of injury presentation to the physiotherapy department declined from 25.3/100 recruits to 13.5/100 recruits (46.6%) from group 1 to group 3 (Table 1). There was a statistically significant decrease in the total number of injuries between group 1 and group 2 (χ² = 14.31, p = 0.0002) but no statistically significant decrease between group 2 and group 3 (χ² = 2.75, p = 0.10).
Injury Reduction with a Modified Physical Training Program

TABLE I
NUMBER AND RATE OF RECRUIT INJURIES, JULY 1995 TO MARCH 1996

<table>
<thead>
<tr>
<th>Group 1 (July to October 1995)</th>
<th>Group 2 (October 1995 to January 1996)</th>
<th>Group 3 (January to March 1996)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Platoons</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>No. of recruits</td>
<td>708</td>
<td>662</td>
</tr>
<tr>
<td>No. of injured</td>
<td>179</td>
<td>112</td>
</tr>
<tr>
<td>Injury rate</td>
<td>253/1,000</td>
<td>169/1,000</td>
</tr>
</tbody>
</table>

Figure 1 shows the rate of injury in each of the three groups, by gender. Male recruits had a reduction in injury rate of 45.5% between groups 1 and 3 ($\chi^2 = 9.97, p = 0.0016$). There was a significant decrease between groups 1 and 2 ($\chi^2 = 10.49, p = 0.0012$), but no significant decrease between groups 2 and 3 ($\chi^2 = 0.003, p = 0.97$).

Rates of Medical Discharge

Figure 2 shows the rates of medical discharge for the years 1992/1993 to 1995/1996. The male medical discharge rate increased steadily from 1992/1993 to 1994/1995 and then decreased from 81.1/1,000 recruits to 47.0/1,000 recruits in 1995/1996. This reduction of 33.1/1,000 recruits was statistically significant ($\chi^2 = 26.33, p = 0.0001$).

During the same period, the female medical discharge rate increased from 45.5/1,000 recruits to 142.2/1,000 recruits. The increase between 1994/1995 and 1995/1996 was statistically significant ($\chi^2 = 6.09, p = 0.014$). Medical discharge as a percentage of total male discharges decreased from 52.1% to 35% between 1994/1995 and 1995/1996. In females, this percentage increased slightly from 53.7% to 57.7% during the same period.

Cost Savings

The cost of acquiring and transporting a recruit to IRTB has been calculated as $9,000 Australian (A$9,000), and if discharge occurred after 10 weeks, the net cost was estimated to be A$14,245.12. This figure takes into account salary, housing, food, and training resources.

TABLE II
NUMBER AND RELATIVE RISK OF MALE AND FEMALE INJURY, JULY 1995 TO MARCH 1996

<table>
<thead>
<tr>
<th>Group 1 (July to October 1995)</th>
<th>Group 2 (October 1995 to January 1996)</th>
<th>Group 3 (January to March 1996)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of males</td>
<td>554 (78%)</td>
<td>578 (89%)</td>
</tr>
<tr>
<td>No. of females</td>
<td>154 (22%)</td>
<td>89 (14%)</td>
</tr>
<tr>
<td>Males injured</td>
<td>125 (22.5%)</td>
<td>87 (15%)</td>
</tr>
<tr>
<td>Females injured</td>
<td>54 (35%)</td>
<td>29 (28%)</td>
</tr>
<tr>
<td>Female relative risk</td>
<td>1.55</td>
<td>1.87</td>
</tr>
</tbody>
</table>

With a male recruit population of 2,700 in 1995/1996, the reduction in medical discharge rate represented a saving of 89 recruits, resulting in an estimated cost saving of A$1,267,805. For the females, the increase in rate was 60.2/1,000 recruits in 1995/1996. With a population of 481 recruits, this represented an increased loss of 29 recruits, for an additional cost of A$413,105.

The number of bone scans ordered by the same medical officer after intervention decreased by 50% (Table III), from 14.4/100 recruits to 7.1/100 recruits ($\chi^2 = 19.33, p = 0.0001$). This reduction represented a saving of 7.3 scans/100 recruits, which at A$281 per scan represented a saving of A$2,000. With a recruit population of approximately 3,000 per year, this would equal a saving of 220 bone scans per year, or A$61,539 per year.

Discussion

Reducing injury in military recruits has a number of advantages to armies. It reduces the cost of medical treatment, compensation benefits, and discharge expenses. First-time pass rates in training institutions improve, but most importantly, it speeds the reinforcement of combat units with personnel shortfalls.

TABLE III
NUMBER AND RATE OF BONE SCANS BEFORE AND AFTER CHANGES TO THE PT PROGRAM

<table>
<thead>
<tr>
<th>June to September 1995</th>
<th>November 1995 to February 1996</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of recruits</td>
<td>834</td>
</tr>
<tr>
<td>No. of bone scans</td>
<td>119</td>
</tr>
<tr>
<td>Rate of bone scans</td>
<td>14.4</td>
</tr>
<tr>
<td>per 100 recruits</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1. Rate of physiotherapy presentations for injury, July 1995 to March 1996.

Fig. 2. Rate of recruit medical discharge, by sex, 1992/1993 to 1994/1995.
There was a 46.6% reduction in the total rate of injury presentation to the physiotherapy department after the changes to the physical training program. The majority of this reduction occurred in male recruits, with the observed reduction of injury in the female recruits not being statistically significant.

Because of the limitations of the study design, it is not possible to hypothesize about causes. The changes to the PT program were introduced together, and there were no control groups. The significant reduction in injury rates indicates the need for further controlled studies to determine which changes had the greatest impact on injury rates.

The observed reduction in male recruit medical discharges demonstrated the potential for significant cost savings. The decrease in male medical discharge was of the order of 33.1/1,000 recruits, which equated to a saving of A$471,509 per 1,000 recruits trained. In 1995/1996, 2,700 male recruits were trained, providing a saving of A$1,267,805.

This figure does not take into account reduced medical, rehabilitation, and compensation costs. The annual savings in bone scans alone was estimated to be A$61,000. The tangible benefits of injury prevention can be clearly observed.

The changed physical training program appeared to have a differential effect, with the reduction in male injury rates being much greater than that in female rates. The reduction in male injury rates was reflected in the medical discharge rates, with a 40% reduction between 1994/1995 and 1995/1996. During this same period, however, female medical discharge rates increased by 60%.

Part of this steep increase may have been attributable to a change in the holding policy within the rehabilitation platoon at IRB. A limit of 8 weeks was set for recovery, and if a condition was deemed to require more time, then the recruit was discharged. Anecdotal evidence suggested that females were more likely to require longer recovery times for injury. Stress fractures were the most common cause in this category, and all recruits were discharged and invited to reenlist in 12 months.

Although this policy may have increased the discharge rate for females, it did not do so for males. The decline in the male discharge rate, coupled with the reduction in bone scans ordered, suggests that the changed program may have had the positive effect of reducing clinically significant stress fractures in males.

Other potentially confounding factors are time of year and changes in training staff. Anecdotally, the "best" recruits are arrived in midyear, when, after exhausting all other options, they choose a military career. Training staff members also rotate during the January period, so at least one-third of the staff members will have been new during the January period.

These factors, however, are constant and regular: the large and statistically significant decrease in the annual medical discharge rate suggests that the changed PT program, rather than cyclical events, was responsible. The medical discharge rates had increased steadily between 1992/1993 and 1994/1995 for both sexes. The low rates in 1992/1993 were attributable in part to the very small number of recruits in that year (fewer than 1,000). This corresponded with an economic recession in Australia, with reduced wastage of trained soldiers and much higher recruit entry standards.

The relative risk of female recruit medical discharge in 1995/1996 was 3.38. The risk of female medical discharge has increased steadily since 1992/1993, when the discharge rates were comparable. The relative risk of female injury increased slightly after the change, from 1.55 to 1.86, but this was mainly attributable to the significant reduction of injury risk in the male recruits.

The increase in female medical discharge rates, in the presence of declining injury rates, is a concern. This suggests that although the number of injuries declined, the severity increased. The exact reasons for this discrepancy are currently being investigated.

Even with the reductions seen, the female injury rate was 1.8 times greater than that for the males, and this may be attributable to the different levels of initial fitness. Recent work done at IRB suggests that initial levels of fitness (as measured by a 20-m shuttle run) are highly predictive of subsequent recruit injury.13

This is consistent with other research, which found that the risk of injury for male and female U.S. Army recruits was equivalent when compared by level of fitness. When stratified by 1-mile run time tertiles, male and female U.S. Army recruits had equivalent rates of injury, with the highest rate occurring in the lowest tertile. These findings are consistent with other research in both civilian and military settings.

Ryan16 argued that this discrepancy was attributable to poor conditioning. The better conditioned the athlete was, the less susceptible to injury. Among highly trained athletes in the same sports, there was little difference in injury rate. Albon17 argued that conditioning programs that aimed at achieving the highest levels of strength and endurance would give females the best defense against injury.

In a survey of 361 U.S. colleges involving 19 major sports, Gillette18 found that respondents felt that improper training methods, including inadequate conditioning before sport commencement and a lack of modern training methods, were major factors in injuries to female athletes.

In a study of female officer candidates at West Point in 1977, women were found to have higher rates of injury. It was noted, however, that none of the women who scored highest on the initial fitness tests incurred any injuries during the training period. The researchers concluded that the females' initial level of fitness affected their susceptibility to injury. They also commented that cultural mores might be significant in that there was a preponderance of young adult women with poor fitness levels who had never been physically challenged.

The findings of this study call into question the benefits of integrated physical training for men and women during Army recruit training. There would appear to be a "gap" in the initial
levels of fitness, and this is not taken into account in the application of a physical training regimen that has fixed and not relative demands.

In the military mindset, women are often considered “little men,” and this attitude fails to consider the fundamental physiological differences between men and women. Males have larger, longer, and denser bones. Male muscle and bone mass is approximately 10 kg greater than that of females. Increased male size and muscle mass provides superiority in leverage and strength. The average muscle strength of women is two-thirds that of men. The average female will have approximately 3 kg more subcutaneous fat than her male counterpart, resulting in relatively greater weight for height.

In the age group 20 to 30 years, women have 15% less hemoglobin and 6% fewer red blood cells per milliliter of blood, demonstrating a decreased oxygen-carrying capacity. After age 12, female maximal aerobic capacity decreases to 70% to 75% of male capacity. The aerobic capacity of both sexes peaks at 18 to 20 years.

Although there is no question regarding a fixed end point of fitness for military service, if the time to achieve that end point is fixed and there are different start points, the net result will be a major difference in both the absolute and relative amounts of effort and improvement needed.

For example, if the aerobic end point is 55 ml/kg/min, then a recruit who enters with 50 ml/kg/min will achieve the end point more easily than a recruit who enters with 35 ml/kg/min. One will require a 10% increase in aerobic capacity and the other will require a 57% increase, both within the same time.

The current system of variable start points and a fixed end point is a recipe for injury, particularly given the low levels of initial fitness seen in females. The approach to initial entry physical training needs to be reviewed in the light of new and old findings, with more emphasis on the establishment of a minimum aerobic start point and the rate of progression to the desired end point.

The logical approach is to ascertain a minimum fitness start point for recruit physical training. This will ensure that all recruits have the requisite level of initial fitness to withstand the rigors of a demanding physical training program. There is some evidence to suggest that women joining the Australian Army who fall below a set minimum level of aerobic fitness have a greater than 50% risk of injury and subsequent discharge.

There are two possible options that could be adopted. The first is to screen all entrants at recruiting centers and accept only those who meet the minimum fitness entry standard. This will immediately reduce the number of female recruits and may be politically unacceptable. The second is to develop an alternative physical training program for recruits who fail to meet the initial standard. This will accommodate a lower start point and a more gradual increase in intensity.

Both of these options would require a cultural change in the underlying egalitarian ethos of armies, or the “equal pay for equal work” ethic. Although this should apply to soldiers already in service, who must be capable of meeting the physical demands of their various duties, in trainees the situation warrants review.

In summary, modifications to the physical training program appeared to significantly reduce the rate of both injury and medical discharge in male recruits. The high rates of injury and medical discharge in female recruits is a concern and may require a reevaluation of the current concepts of integrated recruit physical training.

Postscript

As a result of this and other research, a screening fitness test has been introduced at all Australian Army recruiting centers. The recruit course has been reduced to 6 weeks, commencing October 1, 1997, and the physical training program has been completely rewritten. The rate of male medical discharge at 1RTR between October 1, 1997, and April 30, 1998, was 22.5/1,000 recruits ($N = 1,334$); the female rate decreased to 50.4/1,000 recruits ($N = 218$).

References