# Does military service damage females? An analysis of medical discharge data in the British armed forces

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There is anecdotal and some scientific evidence that females in military service experience an excess of work-related injuries, compared with males. To investigate this more fully, we analysed data collected routinely by the Defence Analytical Services Agency on medical discharges in male and female personnel in the British armed forces. We found that for all disease and injury categories of medical discharge there is a statistically significant excess in females; this disparity is particularly marked for discharges on account of injury [relative risk (RR) = 1.65, 95% confidence interval (95% CI) = 1.30–2.10] and musculoskeletal disease (RR = 3.34, 95% CI = 2.75–4.06). Royal Navy females are eight times more likely (RR = 7.92, 95% CI = 3.03–20.66) and Army females seven times more likely (RR = 6.53, 95% CI = 2.60–16.42) than Royal Air Force females to be medically discharged on account of injury. Over the period 1993–1996, there was a statistically significant increase in the rate of medical discharge for both musculoskeletal disease and injury in female personnel in the British armed forces. During the period 1996–2000, a marked gender differential was maintained, but the rate of increase in females reached a plateau. We concur with previous investigators that mixed-sex training imposes particular ergonomic stresses on females and that it is a major risk factor for overuse injury. We discuss other possible explanations for the marked gender differential in medical discharge rates in the military. Some changes to training programmes are now being introduced to correct this health inequality, but further interventions are needed. Modifications to training programmes must be audited systematically and candidate interventions tested through randomized controlled trials.

Key words: Female; fractures; gender differences; health inequality; injury; military; training; musculoskeletal; soft tissue injury.

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## Introduction

There is anecdotal evidence, and some corroboration from cohort studies, that the training programme in the UK military preferentially damages females, such that the overall medical discharge rates for females may be 2–3 times that of males [1,2]. In the US Army, studies carried out during initial training have consistently reported injury rates in female trainees that are 1.5–2.0 times higher than those for males [3]. Similar data have been reported by the Australian military [4].

The ultimate aim of military training is to ensure that recruited civilians become equipped both mentally and physically to meet the demands of modern warfare and that in doing so they acquire the ability to fight and win in battle. Designers of military training courses face the challenge of having to balance this inflexible endpoint within a system that on the one hand does not 'break' its recruits and on the other hand does not compromise their eventual safety on the battlefield.

Military recruits undergo a process of selection prior to entering a training establishment. Part of this selection

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process is aimed at determining physical fitness, as it is recognized that recruits vary widely in their previous exposure to physical activity. Despite careful screening for those who are unable to reach minimum physical standards, training injuries remain common amongst recruits and in some cases can result in early medical discharge.

Studies undertaken to find a cause for the apparent gender differential in military injury rates have considered intrinsic factors (i.e. factors specific to the individual), equipment factors and training regimen factors.

Jones *et al.* [3] conducted a prospective cohort study in US Army trainees over an 8 week period to identify intrinsic risk factors for injury in male and female recruits. They found the risk factors to be: gender, low levels of running performance, high and low body mass index (BMI) in men and women, and short stature in women. They further postulated that the lower level of physical fitness seen in new female recruits when compared with males indicates that gender *per se* is not an independent risk factor for injury, but rather that it is the underlying lack of physical fitness (seen predominantly in new female recruits) that causes the gender-specific excess in injury rates.

Neely [5] undertook a military-sponsored literature review to explore the possible intrinsic risk factors for exercise-related lower limb injury. She found that risk was multifactorial, but that being female encompassed many of the known physiological and anatomical risk factors (such as shorter stature and shorter stride length) and increased the overall risk.

Bergman and Miller [2] carried out a retrospective analysis of the clinical records of 49 British Army females who had been discharged for musculoskeletal disorder or injury. They found that being a recruit was strongly associated with medical discharge for these conditions. They also suggested that amenorrhoea, meat avoidance, poorly fitting footwear and (paradoxically) intensive exercise were other potential risk factors for female injury and musculoskeletal disease.

Gemmell [6] noted that overuse injuries amongst female recruits subjected to 'gender-free' training rose significantly as the proportion of females in the intake fell; thus at one Army Training Regiment (Bassingbourn) the female proportion of the intake fell by 25%, but the rate of overuse injuries in females rose by a factor of 15 [95% confidence interval (95% CI) = 3.3–69.5]. This finding agrees broadly with the conclusions derived by Hill *et al.* [7] from their clinical series: mixed-sex training places increased ergonomic stress on females and so becomes a major risk factor for overuse injury.

The prevention of overuse injury (where this was defined as the occurrence of stress fractures) has been studied extensively in both Australian and US military populations. Ross [4] looked at the environmental effects of chronic fatigue, hard training surfaces, drill method and the 'distance run' during training in the Royal Australian Air Force. He found that by reducing running distances and speeds, and by judiciously varying the surface used for running (balancing hard asphalt against soft but unpredictable grass), a reduction in tibial pathology could be achieved.

Hill *et al.* [7] and Pope [8] both found that there was a male:female difference in stride length during marching and that, in mixed marching, the platoon defaulted to the male stride, placing women at a disadvantage and at increased risk of stress fracture of the pelvis. Pope additionally found that encouraging individual stride length in females, and reducing the amount of 'drill' undertaken, helped to reduce the stress fracture rate from 11.2 to 0.6%. The training programme was further modified by placing women at the front of the platoon, thus enabling them to set the stride length. This also reduced the incidence of stress fractures [8].

Jones and Knapik [9] found that the effect of working to near-maximum physiological levels increases the chance of injury, as individuals with a low aerobic potential will experience greater physiological stress relative to their maximum capacity. Heir [10] studied musculoskeletal injuries in Norwegian officer training and established that women exercise close to their maximum output when equalling male exercise performance and that this phenomenon is probably a contributory factor in causing an injury excess in females. In addition, he looked specifically at the effects of gender and age on injury rates. He found that female gender and an increase in age independently increased the risk of injury, and that the vulnerable point in recruit training lay within the first few weeks of joining the military.

Previous research thus agrees that there are factors within the military environment that place females at greater risk of injury. What is less clear is which factors are involved in which injury processes, what the relative contribution of these factors is in the aetiology of injury, which gender-related risk factors are amenable to modification, and which can and should be eradicated.

We carried out this study to determine whether or not discharge data collected routinely within the UK military support the suggestion that there is an excess of medical discharges in female personnel relative to males. Our additional aims were to assess the pattern of medical discharge in females over time and to try to identify possible remedies for gender differentials in this area.

## Methods

The Defence Analytical Services Agency (DASA) in Bath routinely receives data from all clinical consultations in the British armed forces resulting in a medical discharge. In May 2001 we applied to DASA for statistics on male and female medical discharges during the period

1985–2000, filtered by service [i.e. Army, Royal Navy and Royal Air Force (RAF)] and by diagnostic category. We used the ratio of the female:male incidence rates as an estimate of relative risk (RR) and calculated the 95% CI for each RR.

We used the $\chi^2$ test for trend, equivalent to simple linear regression, to examine evidence for a linear trend in discharge rates.

## Results

Table 1 shows the discharge rates per 1000 'strength' in the year 2000 for males and females, together with the RR and 95% CI intervals for female data in relation to male data.

There is a clear excess in the discharge rate in females for musculoskeletal disease and all injuries. The only statistically significant single category in the 'other' medical conditions was that for mental disorder (RR = 2.45, 95% CI = 1.55–3.88), based on a rate for females of 1.33 per 1000.

Figure 1 shows the musculoskeletal disease and injury discharge rates for males and females over the period 1985–2000, culminating in the rates presented in Table 1. Qualitative examination of the data suggested different patterns pre- and post-1993 for all time series examined and we have therefore reflected this in our quantitative analysis.

**Table 1.** Discharge rates per 1000 males and females for selected medical causes in the British armed forces in the year 2000

| *Condition* | *Male* | *Female* | *RR and 95% CI* |
|---|---|---|---|
| Musculoskeletal disease | 2.35 | 7.85 | 3.34 (2.75–4.06) |
| All injuries | 2.76 | 4.56 | 1.65 (1.30–2.10) |
| 'Other' medical conditions | 2.18 | 4.20 | 1.93 (1.50–2.49) |
| Total | 7.28 | 16.6 | 2.28 (2.01–2.59) |

For female injury, there is no evidence of a trend during 1985–1993 ($\chi^2 = 1.64$, 1 d.f.), but a dramatic rise occurred in the period 1993–2000 ($\chi^2 = 80.35$, 1 d.f.). This increase is mainly accounted for by a rise during 1993–1996 ($\chi^2 = 128.15$, 1 d.f.). There is evidence that the increasing rate of discharge has now reached a plateau, with the year 2000 rate being similar to that of 1997/1998 and statistically significantly below that of 1999 (RR = 0.65, 95% CI = 0.48–0.86).

A similar pattern is seen for the female musculoskeletal disease data, particularly over the period 1993–2000. In the earlier years 1985–1993, there is a slight increasing trend ($\chi^2 = 28.99$, 1 d.f.), followed by a large increase in rates during 1993–1996 ($\chi^2 = 76.53$, 1 d.f.). Thereafter, there is a levelling, with the 1999 rate being similar to the 1996 rate and not statistically significantly different from the 2000 rate (RR = 1.23, 95% CI = 0.97–1.54).

The male injury discharge rate shows a sustained increase from a level of 0.7 per 1000 in 1993. A slight downward trend to 1993 ($\chi^2 = 71.53$, 1 d.f.) is followed by an increasing trend over the period 1993–2000 and in particular 1993–1996 ($\chi^2 = 331.88$ and 310.74, respectively, 1 d.f.). These rate data have also levelled over the last 5 years, with the 2000 rate being not statistically significantly different to the 1999 rate (RR = 1.11, 95% CI = 0.98–1.25).

In contrast, the male musculoskeletal disease rate shows no evidence of trend over the period 1993–2000 ($\chi^2 = 0.25$, 1 d.f.).

**Figure 1.** Medical discharge rates for musculoskeletal disease and injury by gender, 1985–2000.

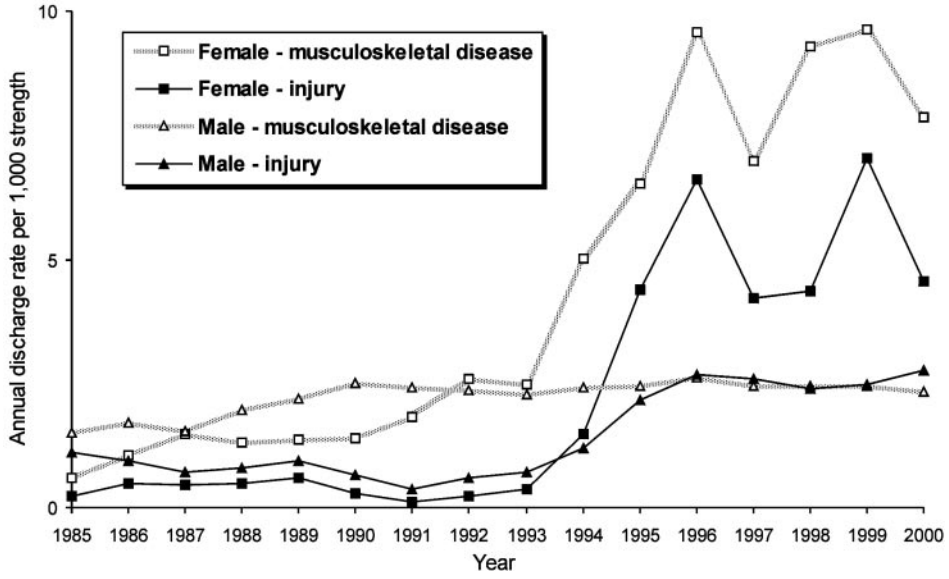

Figure 2 further explores the data on medical discharges in females. Here, the data on musculoskeletal disease and injury over the period 1985–2000 are displayed for each of the three branches of the UK armed forces.

The overall 'tri-service' pattern of discharges in females on account of injury, previously displayed in Figure 1, is mirrored in the data for Army females, while the injury data for Royal Navy females show an increasing trend over 1993–2000 ($\chi^2 = 32.38$, 1 d.f.), leading to the highest rate within the three services in the year 2000, namely 7.21 per 1000. The RAF data are unremarkable, with 1995 levels being maintained over the last 3 years.

In 2000, two of the pairwise service comparisons for female injury were statistically significant, providing RR estimates of 7.92 (95% CI = 3.03–20.66) and 6.53 (95% CI = 2.60–16.42) for the Royal Navy versus the RAF and the Army versus the RAF, respectively.

In contrast, the Royal Navy and RAF data for female discharges on account of musculoskeletal disease show little change over the last 16 years. The data for the Army follow the same pattern as for the Army injuries, the increasing rate of discharge having stabilized and reduced relative to preceding years—the year 2000 rate being 12.9 per 1000 and in comparison with 1999 yielding an RR of 0.79 (95% CI = 0.61–1.02).

Statistically significant relative risks for medical discharge on account of musculoskeletal disease were observed in 2000 for the Army in comparison with the Royal Navy (RR = 2.99, 95% CI = 1.74–5.13) and for the Army in comparison with the RAF (RR = 4.44, 95% CI = 2.62–7.51).

Table 2 consolidates the female versus male RR information for the three services, over the two most recent years.

The table shows that the 4-fold risk for injury observed in 1999 in Army females relative to Army males has reduced by a half in 2000, while the Royal Navy RR of 1.56 in 2000 has just reached statistical significance. There is no evidence of any gender difference in the rate of discharge for injuries in the RAF.

There is also no gender difference in the rate of dis-

**Figure 2.** Medical discharge rates for musculoskeletal disease and injury in female personnel by service, 1985–2000.

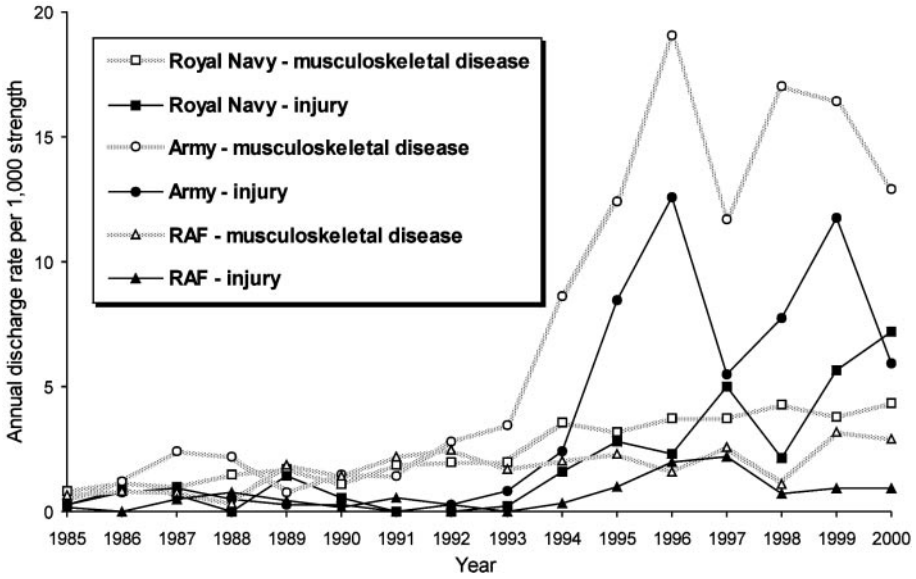


**Table 2.** Female versus male tri-service and individual service RR (95% CI) for medical discharge due to musculoskeletal disease and injury during 1999 and 2000

| *Year* | *Tri-service* | *Royal Navy* | *Army* | *RAF* |
|---|---|---|---|---|
| Musculoskeletal disease | | | | |
| 1999 | 3.94 (3.29–4.72) | 1.07 (0.59–1.93) | 5.62 (4.57–6.90) | 4.77 (2.71–8.39) |
| 2000 | 3.34 (2.75–4.06) | 1.57 (0.91–2.69) | 4.66 (3.71–5.85) | 2.58 (1.48–4.50) |
| Injury | | | | |
| 1999 | 2.83 (2.31–3.47) | 1.47 (0.91–2.36) | 4.24 (3.35–5.36) | 1.19 (0.47–3.02) |
| 2000 | 1.65 (1.30–2.10) | 1.56 (1.03–2.36) | 2.03 (1.49–2.76) | 1.03 (0.41–2.60) |

charge due to musculoskeletal disease in the Royal Navy, but a 2- to 4-fold increase in risk for females over males in the RAF and Army, respectively.

## Discussion

These medical discharge data support the observation made by previous investigators that females suffer more injuries and musculoskeletal problems as a result of training and service in the military [2]. Our analysis includes data from both trained and untrained personnel.

It is well recognized that the self-reporting of sickness events is subject to gender bias, in that women are more likely to self-report [11]. Our study avoids this bias by restricting the analysis of musculoskeletal disorders and injuries to medical discharges, from which it can be inferred that the recorded outcome was severe enough to impact terminally on working capability.

It has long been recognized that the gender difference we have described is complex and multifactorial, and is not due to one single modifiable risk factor. It would seem obvious that the process of developing and maintaining an elite fighting force will necessarily lead to injury and to elimination of the less fit. Factors that compounded this inevitable attrition during the 1990s included societal pressures for equal employment rights for males and females, and acute staffing shortages within the military. Both of these forces have led to a working environment where some military personnel who are physically less able have been subjected to stresses and strains beyond their natural capabilities.

### General observations

*Army data*

Known biological differences between males and females include the fact that female bones are, in the main, smaller and less able to resist stress than male bones, and that female muscle mass is physiologically weaker and more readily fatigued [12]. Potentially, females will operate at their maximum performance in terms of strength, cardiorespiratory function and flexibility before their male counterparts will do so. It is possible that the observed rise since 1993 in medical discharge rates for musculoskeletal disease and injury in Army females was a direct consequence of the pressures around that time to increase employment opportunities for females and of the decision to allow females to enter training establishments on the same terms as males and following the same training syllabus—the Common Military Syllabus for Recruits, or CMS(R) [2,6].

Because of heavy attrition rates in female recruits during the mid-1990s, a battery of entry tests, known as the Physical Standard Selection criteria, was introduced by the Army around 1997 to try and pre-select those females who would be likely to succeed in the CMS(R). However, owing to recruitment shortfalls at this time, the cut-off point for passing the CMS(R) was progressively lowered in various training establishments, in one case to a point where females allowed to commence the CMS(R) had only a 60% predicted likelihood of completing it successfully [6].

Our data suggest that the previously accelerating medical discharge rates for musculoskeletal disease and injury in Army females have now stabilized. Explanations for this may include: local initiatives to introduce physical training for females at a more gradual pace; the extension of training time allowed for females; and a tendency to 'backsquad' rather than to formally discharge injured females. In recent months, the Army has announced a substantive modification to the training schedule for its female recruits. These changes need to be audited systematically and any proposed future interventions tested through rigorous experimental methods such as randomized controlled trials [13].

*Royal Navy data*

Over the period we studied, medical discharges on account of injury in Royal Navy females showed a gradual increase. There is no obvious explanation for this trend. Employment opportunities for females in the Royal Navy have widened considerably in the past 15 years and it seems likely that it is this phenomenon, rather than any decline in the physical fitness of those recruited, that has led to the progressive rise in discharge rates observed in Royal Navy females.

*RAF data*

With the exception of a transient rise for injuries in 1995–1998, there was little variation over time in the RAF pattern of medical discharges for female personnel. As at 2000, the female:male relative risk for injury was close to one (Table 2), suggesting that the required levels of physical fitness in the RAF may not be as demanding as they are in the other two branches of the UK armed forces.

### Postscript—Training and Exercise Medical Advisory Group

An epidemiological task force known as the Training and Exercise Medical Advisory Group (TEMAG) was established within the UK Ministry of Defence in May 2000, with objectives that included the analysis of training injury rates and trends across the three branches of the armed forces and of the gender differential in particular. It is hoped that in time this task force will develop management protocols based on systematic audit and on well-designed randomized trials [14]. Such protocols

would allow military training to take place in a gender-fair environment and with minimal attrition of personnel, while in no way compromising the desired final product, namely the production and maintenance of an elite fighting force.

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