Ministry of Defence

Interim Report on the Health Risks to Women in Ground Close Combat Roles

WGCC/Interim-Report/10/2016

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Background

This interim report provides an updated position to the 2014 Women in Ground Close Combat (WGCC) review on the health risks to women in GCC roles. The findings will inform a decision by the Secretary of State (SofS) for Defence in mid-2016. In this interim report, the health risks to women in GCC roles have been examined more closely, based on clinical evidence of serving female personnel in Combat Support and Combat Service Support roles, and from our understanding of the risks to men operating in GCC compared with non-GCC roles.

This report presents four key mitigations considered essential for protecting the health, and maximising the physical performance, of women in GCC roles should the restriction to women in GCC roles be lifted in 2016. This interim report is an early submission of a five year research programme; the findings remain preliminary and the risks to, and mitigations for, women in GCC roles will not be fully understood until the remainder of the research programme has matured. The final report will deliver bespoke evidence-based mitigations for the identified health risks. Information presented in the interim and final reports will have benefits to both Service men and women.

Approach

Early analyses of the potential health risks to women in GCC roles were explored in the 2014 WGCC review, and principal concerns included the increased risk of musculoskeletal injuries, mental health and behavioural problems, and impaired reproductive health. In this interim report, these same health risks were evaluated using data collected from various sources. Greater confidence can be placed on these conclusions by triangulating different secondary data sources, particularly given the relatively small population of women in the Armed Forces (~20,000 or 10% of total population).

Musculoskeletal injury data from the ***training*** population were obtained from medical registers. Risk of medical discharge, specific causes of medical downgrading, and outflow from the ***trained*** strength were evaluated from primary health care records (DMICP) triangulated, where appropriate, with the military human resource database (JPA). Specific detail on musculoskeletal injuries was obtained from a purpose-designed survey administered to a representative sample of Service personnel. Appropriate permissions were granted for access to, and collection of, primary data.

Secondary data were also used to support proposed mitigation strategies. Evidence was obtained from two systematic reviews and from the first deliverable of the development of Physical Employment Standards. Two reports were delivered by subject matter experts from academia and Dstl.

Summary of Findings

Musculoskeletal Injuries

- Musculoskeletal injuries were the most common cause of medical downgrading and medical discharge in both Service men and women.
- The risk of musculoskeletal injuries in Army initial training was two-fold higher in women than men, and this risk of injury was higher still for overuse injuries.
- Female trainees were 3 times more likely to suffer a stress fracture injury, and 10 times more likely to suffer a stress fracture at the hip compared to men.
- In men, the risk of musculoskeletal injuries, and specifically stress fractures, was 7 times higher in Infantry trainees than Army Standard Entrants undertaking a less physically arduous course.
- The risk of upper body injuries in Army initial training was similar in men and women.
- The risk of medical discharge was two fold higher in female than male Army trainees, with this risk markedly increased by injuries of the hip.
- Tri-Service women had a higher rate of medical downgrading than men, particularly in the first four years of service.

Postpartum (post-pregnancy)

- Service women reported a higher number of working days lost due to musculoskeletal injury and illness between 26 weeks to 52 weeks postpartum (period after child birth) compared to pre-pregnancy.
- Skeletal health does not fully recover for up to two years post-weaning, increasing the risk of skeletal injury to women in GCC roles.

Mental Health

- Mental health and behavioural disorders were the second most common cause of medical downgrading in Service men and women.
- Service women presented, and were diagnosed, with mental health problems more frequently than Service men. Service women were also more likely to suffer from anxiety and depression than Service men, but it is unknown whether this difference will be worsened by combat exposure of women in GCC roles.

Reproductive Health

- The arduous nature of GCC roles may impair reproductive and musculoskeletal health by disrupting neuroendocrine signalling (between the brain and reproductive organs). Similar effects are seen in athletes engaged in intensive training.
- An initial audit was conducted to examine the occurrence of fertility problems in Service women in primary care.
- Service women were more likely to present to their General Practitioner with fertility problems than age-matched female civilians over 30 years of age, but these findings must be followed up with prospective investigations because confounding factors could not be controlled.

Mitigations

Based on the evidence, the report has identified four mitigation strategies that require implementation if the restriction to women in GCC roles is lifted in 2016. Three of these mitigations are designed to reduce musculoskeletal injury risk and maximise physical performance. Musculoskeletal injuries are likely to have the biggest impact on deployability and military readiness because of the likelihood and volume of injuries that are sustained, and the consequences for medical downgrading and medical discharge. Increased injury risk to women in GCC roles will also add to the financial burden of musculoskeletal injuries, which is currently estimated to cost the Army £1.202 billion over the next 15 years[1].

The other mitigation addresses protection against mental health disorders.

1. Implementation of New Physical Employment Standards (PES)

Matching the physical performance of personnel to the physical demands of a role ('person-job' fit) in an optimised manner is a robust mitigation strategy that will benefit all Service personnel selected, trained, and retained in GCC roles. Development and implementation of PES will improve health and safety (e.g. reduced musculoskeletal injuries) and productivity (e.g. optimising operational effectiveness). The benefit of PES for reducing musculoskeletal injury risk is unknown, but expert opinion is that achieving 'person-job' fit will be protective. The potential benefits of this programme will not be delivered until 2018 for GCC PES, and 2021 for all other roles, due to the scale and complexity of this work.

2. Optimising Physical Training Strategies

Optimal physical training strategies will play an essential role in maximising physical performance of women in GCC roles. Significant improvements in physical performance of women (and men) are achieved with properly designed progressive (periodised) physical training programmes. Special consideration should be given to maximising upper body strength using heavy resistance exercises for optimising performance of women in GCC roles.

The optimal physical preparation of women for GCC roles requires a detailed understanding of the specific occupational demands of GCC specialties. This understanding will evolve from the process of developing valid GCC PES.

3. Injury Prevention Strategies for Women in GCC Roles

The combined strategies of increasing physical fitness and minimising 'time on foot' are likely to benefit acute and overuse injury prevention efforts. Reducing the risk of overtraining and musculoskeletal injury risk in initial training can be achieved effectively with single sex training, which delivers an appropriate progression in training loads for female trainees and scope for greater performance gains in both men and women.

Good leadership and awareness are essential elements of all injury prevention strategies. Appropriately trained personnel should deliver injury prevention strategies to promote adherence, effect change and maximise benefits to injury prevention.

1 For pension and personnel costs alone. Reference: ArmyHQ/Res/MAS(A)/Projects/1-062 dated 23 Mar 16.

Postpartum

Policy will need to be re-considered for preparing Service women in arduous roles for a safe return to work. Consideration should be given to assessing fitness for return to full duties based on whether a woman is breastfeeding or not. This assessment would primarily consider whether the skeleton has returned to its pre-pregnancy state and when ligament laxity has resolved. These changes are likely to be at least 12 months post-weaning.

A postpartum rehabilitation programme may be useful to assess an individual's ligament laxity and allow an individual to return to full fitness in a graduated manner as advised by the Royal College of Obstetrics and Gynaecology.

4. Mental Health Interventions

There is no strong evidence base for the prevention of mental ill-health related to occupation. However, the military currently use mental health 'first aid' to improve peer awareness of the signs of mental ill-health in the workplace, and this model may have utility in reducing the risk of mental ill-health and occupational stress of women in GCC roles if an early positive decision is made.

Perceived levels of cohesion, morale and good leadership are associated with lower self-reported levels of common mental health disorders and Post Traumatic Stress Disorder in UK Armed Forces deployed on HERRICK (2010). Effective leadership may, therefore, be protective for mental health and should be re-enforced in leadership training.

Conclusions

This interim report highlights the risks to women should the restriction to women in GCC roles be lifted, and include in brief:

1. The disproportionate projected risk of musculoskeletal injuries to women in Infantry training. Notably, the propensity to debilitating hip injuries requires special consideration if women are to successfully undertake Infantry training and/or GCC employment.
2. The increased likelihood of medical downgrading in the first 4 years of a woman's career; consideration should be given to how this risk will be managed for GCC employment where the physical demands are likely to be much greater than Service women are currently exposed to.
3. Susceptibility of women to mental ill-health; it is not known how mental ill-health would be affected by Service in GCC roles but consideration needs to be given to the potentially increased psychological demands of GCC employment.
4. The potential risk to female reproductive health from arduous military training. However, further understanding of this potential risk is required.

The issue of women serving in GCC roles challenges the balance between the right to equality and duty of care. There are immediate mitigations that can be introduced for musculoskeletal injuries and possibly mental ill-health. In the absence of validated GCC PES until 2018, ***health surveillance*** of the low number of women likely to enter GCC roles will flag early signs of injury and ill-health for immediate clinical assessment. The underpinning causes of impaired musculoskeletal, mental and reproductive health, and development of bespoke mitigations for women in GCC roles, will be addressed in the remaining research programme, which will also benefit Service men.

Recommendations

1. New optimised Physical Employment Standards for GCC roles are developed and implemented.
2. Optimal, progressive physical training strategies, with special consideration for upper body strength and load carriage performance, are delivered ***through-career*** for women (and men) in GCC roles.
3. Interventions to reduce ***overtraining*** (e.g. excessive distance running) are introduced.
4. Initial training is undertaken in a single sex manner.
5. Women in GCC roles are monitored through-career for early signs of injury and/or ill-health by an occupational physician.
6. Education on injury risk, ill-health, and preventative strategies is provided to all leaders and personnel.
7. Provision of, and access to, Mental Health ***First Aid*** is made available and strongly encouraged at Unit level.
8. Education on appropriate training, postpartum requirements, and dietary needs for women in GCC roles is provided in an updated 'Servicewomen's Guide'[2].
9. Research is continued to identify the causes of injuries, mental ill-health, and impaired reproductive health so that that bespoke mitigations can be developed for the UK Armed Forces population.

2 SWG/v.1.0/Oct 2007, produced by QinetiQ Ltd, funded by HQ ARTD (QINETIQ/D&TS/CHS/GU058505)

1 Introduction

This interim report provides an updated position to the 2014 Women in Ground Close Combat (WGCC) review [1] on the health risks to women in GCC roles. The findings will inform a decision by the Secretary of State (SofS) for Defence in mid-2016. In this interim report, the health risks to women in GCC roles have been examined more closely, based on clinical evidence of serving female personnel in Combat Support and Combat Service Support roles, and from our understanding of the risks to men operating in GCC compared with non-GCC roles.

We present four key mitigations considered ***essential*** for protecting the health, and maximising the physical performance, of women in GCC roles, and estimate the residual risk following implementation of our recommendations, if the restriction of women in GCC roles is to be lifted in 2016. The SofS is to note that this interim report is an early submission of a proposed five year research programme, that the findings remain preliminary, and the risks and mitigations to women in GCC roles will not be fully understood until this work matures.

Background

We provisionally considered the health risks to women in GCC roles for the 2014 WGCC report, and concluded that:

- Smaller body size, lower muscle mass, and higher fat mass disadvantage women in physical performance. Consequently, few women would be able to achieve the pre-employment standards for GCC roles, and may struggle to maintain appropriate physical standards in the ***trained*** strength.
- A principal risk to women is musculoskeletal injuries. Female Army recruits are twice as likely to sustain an injury in training as men, and this risk is likely to increase further still during the longer, more arduous, Infantry training course, when training alongside men on Phase 3 training courses, in Force Preparation and on Operations.
- Robust understanding of the role-related physical demands of GCC roles leading to new optimised physical employment standards may reduce the risk of injury. Currently only validated pre-employment standards based on outdated representative military tasks exist.
- Targeted physical training programmes markedly improve physical performance of women on military occupational tasks, but the implementation, through career monitoring of training and cumulative effects on health must be carefully considered.
- Women engaged in physically demanding occupations should be protected for up to 24 months postpartum.
- Service women have a greater risk of morbidity, including on Operations, although the causes of this are unclear.

It became clear in 2014 that there are significant knowledge gaps in our understanding of the health of Service personnel to provide sufficient leverage to predict risk for women in GCC roles. Further research was recommended, with an interim update delivered in April 2016. In this update, we present further evidence on the health risks to both trainees and trained Service personnel (Section 2), and evidence-based intervention strategies to reduce the risk of injury and/or illness if an immediate decision to lift the restriction of women in GCC roles is made. The risks that this decision will carry, and the residual risk with recommended interventions for musculoskeletal injuries, are illustrated in Section 6.

2 What are the Health Risks to Women in Ground Close Combat Roles?

This interim health report aimed to understand the potential health risks to women operating in GCC roles based on extant health risks to currently serving female personnel, and to men in GCC roles. These health risks were examined ***through-career*** from initial training to regular Service in the trained strength, and compared between men and women and GCC ***versus*** non-GCC roles.

Comparisons between men and women provide an understanding of how the risk of military training/employment to women differs from that of men. Comparisons between Services, roles and training establishments provide an understanding of how the demands of GCC training/employment may alter the extant risk between sexes. However, the projection of a female GCC risk was based on the existing female demographic and did not consider that a GCC female may differ from a non-GCC female. Moreover, inherent differences in course content/length within the training environment, and trade-specific training/exercises in the trained strength are not accounted for, but reflect the current demands of these roles.

Tri-Service data were included where available, but were interpreted with caution since injury reporting or single Service medical policy varies. This interim report examined the occurrences[3] of injury/illness, and their impact on medical downgrading and medical discharge from Service. Data were mainly obtained from existing databases from a number of sources, but limited data were obtained from original research. Data capture from a variety of sources is important as an indication of the consistency of findings.

Standard Entrants at the Army Training Centre, Pirbright (ATC(P)) and Regular trained Service personnel in the Royal Logistic Corps (RLC) have been used as reference groups to understand the risk of GCC training/employment. These demographic groups have been chosen as a reference because of the large group of women in training in a homogenous environment, and due to a likely lower exposure to physically arduous occupational or training demands than GCC roles.

2.1 Data Sources

2.1.1 Defence Medical Information Capability Programme (DMICP)

The Defence Medical Information Capability Programme (DMICP) is the tri-Service electronic medical record system built around the civilian Egerton Medical Information System Primary Care System (EMIS PCS). DMICP is based on the concept of a single integrated health record for primary healthcare and some MOD specialist care providers. DMICP includes a data warehouse and business intelligence tools to enable secondary analysis of data collected through EMIS PCS.

COGNOS (a commercial business intelligence tool) is the principal data mining tool used within DMICP. MOD health information analysts interrogate the anonymised data through role-based access to protect patient confidentiality. DMICP was incrementally rolled out across the Services worldwide during a 6 year period (2007 to 2013) and legacy medical data on current Service personnel were migrated across to DMICP during this time. Free text information entered into the patient record is not available in the data warehouse. DMICP is a live data source and is subject to change.

2.1.2 Joint Personnel Administration (JPA)

The Joint Personnel Administration (JPA) system is a tri-Service harmonised pay and personnel system. JPA is the authoritative source of all Service personnel human resources data and was introduced across Defence in 2007. Individual Service personnel are responsible for ensuring that their data held on JPA are accurate.

3 Occurrences of injury and illness were reported as incidence (all new cases) or prevalence (total number of cases within a given period of time).

2.1.3 DMICP and JPA interface

DMICP has primacy for medical information whereas JPA has primacy for personnel data. Having an electronic interface between these two systems ensures that consistent patient demographic information is maintained on both systems. The purpose of the DMICP-JPA interface is to transfer accurate personnel details from JPA to DMICP and to transfer limited Force Protection medical data (e.g. medical deployment standards, immunisation status) from DMICP to JPA. This process of information transfer from JPA to DMICP ensures that the Chain of Command has visibility of a sub-set of information required for employment/ deployment purposes.

2.1.4 Injury Reporting

Tri-Service training establishments collect and report injury data to allow timely injury pattern analysis and to improve patient care. However, as the training establishments have evolved independently, different methods are used to capture data and tend to reflect the specific policies used by the single Services, making comparison difficult. Data used in this report have been obtained from various sources including injury registers, reports and bespoke requests for information.

2.1.5 Medical Discharge Database: Training

Data were analysed retrospectively using Headquarters Army Recruiting and Training Division (HQ ARTD) medical discharge and injury databases. Army trainee medical discharge data included discharges under Queen's Regulations (QR) 9.385, 9.386 and 9.387. These discharge codes are based on a failure to meet existing standards (9.385) or being unfit for Army Service, either on a temporary or permanent basis (9.386 and 9.387). Data were included if the medical discharge was a result of an injury sustained in training. For each medical discharge, the injured site was identified and categorised. Medical discharge data were grouped according to 'date of Medical Board' and presented per training year if the date of Medical Board fell within that year.

Medical discharge data for trainee Royal Marines were obtained from the Naval Service Medical Board of Survey and only included those where individuals became unfit for Service, similar to the Army discharges under QR 9.386 and 9.387. Data for this interim report were only available for FY 2014/2015.

Medical discharge data for RAF Regiment trainees at RAF Honington were retrieved from the Training Administration and Finance Management Information System. Data were available for courses between September 2011 and July 2015.

Medical discharge procedures differ between Services, and data should be compared with caution.

2.1.6 Defence Statistics (Health) Study Cohort

Defence Statistics (Health) (DS(H)) created a study cohort consisting of all trained Service personnel in the Royal Marines (RM), Infantry, Household Cavalry (HCav), Royal Armoured Corps (RAC), Royal Artillery (RA), Royal Engineers (RE), Royal Logistic Corps (RLC) and RAF Regiment (RAF Regt) who joined the trained strength between 1 January 2010 and 31 December 2015. Data from this cohort were used to establish the length of time to initial downgrading during this six year period and analysis of outflow from the cohort.

2.1.7 A Survey of Musculoskeletal Injuries and Medical Downgrade in Trained Service Personnel

A purpose-designed self-report questionnaire was developed in-house to gain further detail on injury/medical downgrade prevalence in the Regular trained strength, and to understand if these injury/medical downgrade rates differ between sexes and career employment groups. The questionnaire and study design was approved by the Ministry of Defence Research Ethics Committee (723/ MoDREC/16) and the questionnaire was piloted with serving personnel to improve comprehension. Data collection was conducted between February and March 2016.

Surveyed participants were Regular, trained Service personnel from the RM, Infantry, RAC, RE, RA, RLC and RAF Regt. Some individuals from other Combat Service Support roles who were attached to one of these Units also completed the questionnaire. All data were captured in paper format before being transferred to an electronic format for data analysis. Data were expressed relative to the total sample population (i.e. the number of Serving personnel who completed the questionnaire) or relative to the category of interest (e.g. sex/career employment group).

Sample size calculations indicated that 1008 males and 288 females were required for the survey. Comparisons in injury rates between men and women could not be calculated because, due to time constraints, only 53% of the female sample size was reached. Since 104% of the male sample size was achieved, comparisons in injury rates in Service men between roles were analysed.

2.1.8 Data Analysis

Data collected from these various data sources have been expressed as rates of occurrence per 1000 trainees into training, or per 1000 trained Service personnel, at risk. Statistical differences in the risk of ill-health occurrences between sexes were evaluated in datasets collected from training establishments where both men and women train, and from roles containing both male and female trained Service personnel. The risk to Infantry trainees and trained GCC Service personnel was evaluated by comparing these data to Standard Entrant trainees and trained Service personnel in the RLC, respectively.

Statistical differences and the relative risk of ill-health to women (trainees and trained Service personnel) and Infantry trainees/GCC personnel were evaluated using 2x2 contingency tables (GraphPad Prism v6.0, GraphPad Software Inc., CA). The relative risk was calculated from the number of occurrences, and non-occurrences, of ill-health (e.g. musculoskeletal injury) in both the exposed (e.g. female) and reference (e.g. male) populations. For each relative risk, 95% confidence intervals are reported. Statistical significance was evaluated by Chi-square, and assumed at the level $P<0.01$ to account for the potential risk of Type 1 errors with multiple testing.

Values fewer than 5 have been suppressed (denoted as ~) in data tables, in accordance with Defence Statistics rounding policy. Where there is only one cell in a row or column that is less than 5, the next smallest number (or numbers where there are tied values) has also been suppressed so that numbers cannot be derived from totals. Relative risks calculated from cases fewer than 10 have also been highlighted (†). It is important to acknowledge that where the number of reported cases is low, or when proportions from unequal population at risks (e.g. women and men where women account for only ~10% of the Force) are compared, the rates, relative risks and statistical significance of these data can be skewed more than would be the case with greater numbers or equal proportions. We have collected and analysed data from a variety of sources in an attempt to ensure consistency of observation, particularly in instances of low case numbers.

2.2 Health Risks: Training Population

Initial military training is designed to transform a civilian into a trained junior Officer, Soldier, Marine, or Airman. Initial training is undertaken in groups, and individuals train, exercise, eat and sleep in a standardised manner. For these reasons, initial training represents a controlled environment to capture data and understand the health risks of military occupations. The data captured most routinely during initial training are musculoskeletal injuries (MSkI).

Army initial training adopts an Army "soldier first" concept, which exposes all trainees, to an extent, to dismounted training. Army initial military training for Regular Soldiers and Officers is undertaken at five different locations throughout the UK. Three of these training populations were considered in these analyses, including male and female Standard Entrants (SE) at the Army Training Centre, Pirbright (ATC(P)), Infantry soldiers (men) at the Infantry Training Centre, Catterick (ITC(C)) and Officer Cadets (OCdts, men and women) at the Royal Military Academy Sandhurst

(RMAS). Standard Entrants at ATC(P) undertake the Common Military Syllabus for Generic Soldier (CMS(GS)), a 14 week initial training course, prior to trade training during Phase 2. Currently, initial training is performed in single sex platoons. The Combat Infantryman's Course is 26 to 28 weeks in duration, with an initial 12 week period similar in nature to CMS(GS). Officer Cadets undertake a 44 week integrated commissioning course divided into three 14 week terms. The physical demands of these courses vary with ATC(P) being the least, and ITC(C) the most, demanding [2-4].

The initial training course at RAF Halton is 10 weeks and consists of general service training, Force Protection, initial force development and an exercise. Prior to April 2016, RAF Regiment (Gunner) training was delivered as a blended Phase 1 and Phase 2 course at RAF Honington and lasted 24 weeks.

The initial training course at the Commando Training Centre Royal Marines (CTCRM) is 32 weeks long and arguably one of the most demanding of all initial training courses.

2.2.1 Musculoskeletal Injury Risk in Women

Women injure at a higher rate than men during initial military training

Female Army Standard Entrants

All musculoskeletal injuries reported to physiotherapy between September 2011 and December 2015 were analysed by anatomical site and type (e.g. trauma/overuse) of injury. Injury data were expressed by the number of trainees entering training during the same reporting period per 1000 personnel.

- Female Standard Entrants were at 1.60 times the risk of trauma injury and 1.90 times the risk of overuse injury during training compared to male Standard Entrants *(Table A1)*.
- Compared to male Standard Entrants, female Standard Entrants were at;

  3.22 times the risk of ***stress fracture*** injury *(Table A1)*,

  10.39 times the risk of ***hip/pelvis stress fracture*** injury *(Table A1)*,

  5.77 times the risk of ***hip overuse*** injury *(Table A2)*,

  5.04 times the risk of ***thigh overuse*** injury *(Table A2)*,

  1.35 times the risk of ***knee overuse*** injury *(Table A2)*,

  1.67 times the risk of ***calf/shin overuse*** injury *(Table A2)*,

  1.92 times the risk of ***ankle overuse*** injury *(Table A2)* and,

  2.13 times the risk of ***foot overuse*** injury *(Table A2)*.

Female Army Officer Cadets

- Female Officer Cadets were at no greater risk of trauma injury during training compared to male Officer Cadets. The relative risk of overuse injury between male and female Officer Cadets could not be determined as the number of reported overuse injuries exceeded the numbers into training *(Table A1)*. The greater number of overuse injuries than trainees is likely due to individuals reporting more than one injury to the medical chain.
- Compared to male Officer Cadets, female Officer Cadets were at;

  4.38 times the risk of ***stress fracture*** injury *(Table A1)*,

  18.75 times the risk of ***hip/pelvis stress fracture*** injury[4] *(Table A1)*,

  2.95 times the risk of ***hip overuse*** injury *(Table A2)*,

  1.49 times the risk of ***calf/shin overuse*** injury *(Table A2)* and,

  1.69 times the risk of ***foot overuse*** injury *(Table A2)*.
- Female Officer Cadets were at no greater risk of ***thigh, knee or ankle*** overuse injuries than male Officer Cadets *(Table A2)*.

4 <5 hip/pelvis stress fracture injuries.

Female RAF trainees

Medical injury data by anatomical site were provided from McTeague, the rehabilitation Unit at RAF Halton and thus do not include all injuries reported to the medical chain. Musculoskeletal injury data were provided and analysed for training years 2014/2015 and 2015/2016. Injury records for pelvic stress injuries were provided and analysed for training years 2009/2010 to 2015/2016. All data were expressed by the number of trainees into training during the same reporting period per 1000 personnel.

Compared to male RAF trainees, female RAF trainees were at;

2.93 times the risk of ***all*** MSkI,

14.36 times the risk of ***hip*** injury,

3.39 times the risk of ***lower limb overuse*** injury and,

48.40 times the risk of pelvic stress injury *(Table A4)*. Numbers of ***pelvic stress*** injuries in male RAF trainees were very low (n=5).

- Female RAF trainees were at no greater risk of ***upper limb*** or ***trauma lower limb*** injuries than male RAF trainees[5] *(Table A4)*.

5 Numbers were <10

Female Naval Trainees

No musculoskeletal injury training data were provided from the Royal Navy or CTCRM.

2.2.2 Musculoskeletal Injury Risk in Infantry Trainees

Infantry trainees injure at a higher rate than male Standard Entrants during initial military training

- Male Infantry trainees were at **1.37** times the risk of ***trauma*** injury and 2.98 times the risk of ***overuse*** injury during training compared to male Standard Entrants *(Table A3)*.
- Male Infantry trainees were at **7.12** times the risk of ***stress fracture*** injury compared to male Standard Entrants *(Table A3)*.
- Male Infantry trainees were at **7.56** times the risk of ***hip/pelvis stress fracture*** injury compared to male Standard Entrants *(Table A3)*.

2.2.3 Medical Discharge: Army

Army female trainees are at greater risk of medical discharge due to musculoskeletal injuries in training than men

All medical discharges (MD) from Army initial military training between April 2012 and December 2015, resulting from musculoskeletal injuries, were analysed by anatomical site and type of injury (e.g. trauma/overuse). MD data were expressed by the number of trainees entering training during the same reporting period per 1000 personnel. Information on data analysis is given in Section 2.1.9.

3.86% of women (n=88 female trainees) and 4.18% of men (n=961 male trainees; including Infantry) were medically discharged from Army Initial Military Training over the period of data analysis. When Infantry trainees were excluded from male medical discharge rates, 1.49% of men (n=213 male trainees) were medically discharged from Army Initial Military Training. The majority of MD from Army Initial Military Training was due to musculoskeletal injury, particularly of the lower limb.

- Female Standard Entrants were at **1.90** times the risk of MD from training due to MSkI compared to male Standard Entrants *(Table A5)*.
- Female Officer Cadets were at **4.57** times the risk of MD from training due to MSkI compared to male Officer Cadets *(Table A5)*.
- Female Standard Entrants were at **9.22** times the risk of MD from training due to hip injury compared to male Standard Entrants *(Table A5)*.
- Female Officer Cadets were at **12.85** times the risk of MD from training due to hip injury compared to male Officer Cadets *(Table A5)*.
- Female Standard Entrants were at **2.19** times the risk of MD from training due to lower limb injury compared to male Standard Entrants *(Table A5)*.
- Female Officer Cadets were at **4.29** times the risk of MD from training due to lower limb injury compared to male Officer Cadets *(Table A5)*.
- There was no significant difference in the risk of MD from training due to upper limb injury between men and women in either Standard Entrants or Officer Cadets *(Table A5)*.

Infantry trainees are at greater risk of medical discharge due to musculoskeletal injuries in training than male Standard Entrants

- Male Infantry trainees were at **5.63** times the risk of MD from training due to MSkI compared to male Standard Entrants *(Table A6)*.
- Male Infantry trainees were at **5.58** times the risk of MD from training due to lower limb injury compared to male Standard Entrants *(Table A6)*.
- Male Infantry trainees were at **16.24** times the risk of MD from training due to hip injury compared to male Standard Entrants *(Table A6)*.
- Male Infantry trainees were at **4.57** times the risk of MD from training due to upper limb injury compared to male Standard Entrants *(Table A6)*.

2.2.4 Medical Discharge: RAF Regiment

All MD from RAF Regiment training (male) at RAF Honington between September 2011 and July 2015 were analysed. MD data were expressed by the number of trainees entering training at the same time-point per 1000 personnel. Information on data analysis is given in Section 2.1.8.

- 22.19 per 1000 (15 medical discharges of 676 into training) RAF Regiment trainees were medically discharged from initial military training at RAF Honington.

2.2.5 Medical Discharge: Royal Marines

All MD from RM training (male) at the CTCRM, Lympstone between April 2014 and March 2015 were analysed. MD data were expressed by the number of trainees entering training during the same reporting period per 1000 personnel. Information on data analysis is given in Section 2.1.8.

- 55.09 per 1000 (33 medical discharges of 599 into training) RM trainees were medically discharged from initial military training at Lympstone.

Summary

In the training environment, female Army and RAF trainees were at greater risk of MSkI than male Army and RAF trainees at the same training establishments. Specifically, overuse injuries of the lower limb and hip were of particular concern. Female Army trainees also were at greater risk of MD due to MSkI than male Army trainees. Infantry trainees were at greater risk of overuse (including stress fracture) and trauma injuries, and medical discharge due to MSkI, than Army Standard Entrants. Together, these data suggest that women may be at even greater risk of injury and MD if they undergo current Infantry training at ITC(C).

2.3 Health Risks: Trained Strength

Following initial military training, individuals move into their trade training and on to the trained strength to continue developing their military careers. In contrast to the initial training environment, the trained strength represents a less-controlled environment for data capture due to data management differences between Units. Population data are held on central databases, including DMICP and JPA. Although these systems were not primarily developed for research purposes, these data can provide insight into medical downgrading, transfer, and outflow trends.

Data on the occurrence of injury in the trained strength are not reliably recorded on DMICP. Therefore, a cross-sectional questionnaire of self-reported injuries and current medical downgrade status was designed to supplement DMICP data. Causes of medical downgrading were also retrieved from DMICP by DS(H) to understand differences in injury patterns by sex, and between GCC and non-GCC roles. However, the function on DMICP to code medical downgrade data by cause has only recently been developed and complete datasets are not yet accessible.

DS(H) also retrieved data on a specific cohort of Service personnel for the purpose of evaluating the percentage of transferees within, and outflow from, the Service, and the proportion of individuals medically fit for duty. The outflow population data may indicate a 'Healthy Worker Effect' (HWE) which may influence medical downgrade and medical discharge rates. The HWE describes the deficit of morbidity in workers compared with the general population, and is based on the premise that individuals may leave employment when the demands of their job exceed their physical and mental capacity. This report was unable to establish the health effects of those leaving the Service, thus the impact of the HWE will need further investigation.

2.3.1 Medical Downgrading

Personnel suffering from an injury or ill-health can be medically downgraded, either on a ***Temporary*** or ***Permanent*** basis, if they are unable to perform their job. The Joint Medical Employment Standard (JMES) applies to all three Services and includes a Medical Deployment Standard (MDS) that allocates Service personnel to one of the following categories: Medically Fully Deployable (MFD); Medically Limited Deployable (MLD); and, Medically Non Deployable (MND). The deployability status of personnel tends to reflect the severity of illness or injury. However, each of the three Services have different criteria for downgrading and discharge for the Trained Strength population.

We have previously reported a higher percentage of ***Temporary*** and ***Permanent*** medical downgrading in female trained Service personnel (excluding pregnancy) compared to their male counterparts [1]. However, these sex differences were not consistent across all roles. Data provided from DS(H) as a cross-sectional ***'snapshot'*** of the trained strength at 01 November 2015 and from the DS(H) study cohort at 4 years of Service (Section 2.1.6) have been analysed to

evaluate differences in the rate and relative risk of medical downgrading (***Temporary*** and ***Permanent***) by sex and role.

Causes of medical downgrading data for trained tri-Service personnel were provided by DS(H) as a cross-sectional 'snapshot' of data as at 1 November 2015.

Service women are medically downgraded more frequently than Service men in the Trained Strength

- Royal Logistic Corps Service women were at **1.59** times the risk of medical downgrading (all-cause) than Royal Logistic Corps Service men *(Table A8)*.
- Royal Artillery Service women were at **1.17** times the risk of medical downgrading (all-cause) than Royal Artillery Service men *(Table A8)*.
- There was no significant difference in the risk of medical downgrading (all-cause) between Service men and women in the Royal Engineers *(Table A8)*.

Men in Ground Close Combat and Royal Engineer roles are medically downgraded less frequently than those in the Royal Logistics Corps

- Infantry Service men were at **0.80** times the risk of medical downgrade (all-cause) than Royal Logistic Corps Service men *(Table A9)*.
- Household Cavalry/Royal Armoured Corps Service men were at **0.77** times the risk of medical downgrade (all-cause) than Royal Logistic Corps Service men *(Table A9)*.
- Royal Marine Service men were at **0.54** times the risk of medical downgrade (all-cause) than Royal Logistic Corps Service men *(Table A9)*.
- RAF Regiment Service men were at **0.43** times the risk of medical downgrade (all-cause) than Royal Logistic Corps Service men *(Table A9)*.
- Royal Engineers Service men were at **0.87** times the risk of medical downgrade (all-cause) than Royal Logistic Corps Service men *(Table A9)*.
- The risk of medical downgrade (all-cause) did not significantly differ between Royal Artillery Service men and Royal Logistic Corps Service men *(Table A9)*.
- Royal Engineers Service women were at **0.52** times the risk of medical downgrade (all-cause) than Royal Logistic Corps Service women *(Table A9)*.
- Royal Artillery Service women were at **0.73** times the risk of medical downgrade (all-cause) than Royal Logistic Corps Service women *(Table A9)*.

2.3.2 Causes of Medical Downgrading

The causes of medical downgrading in trained tri-Service personnel were provided by DS(H) as a cross-sectional cohort 'snapshot' of data as at 1 November 2015.

Musculoskeletal disorders are the primary cause of medical downgrading in both Service men and women

Musculoskeletal disorders are the leading cause of medical downgrading in both men and women *(Appendix B)*. The rates and relative risks of medical downgrade due to musculoskeletal disorders between men and women and role are presented in *Tables A8 and A10*, respectively. However, there were a number of unspecified reasons for medical downgrade *(Appendix B)*.

Of the medical downgrades where musculoskeletal disorders were specified as the cause of medical downgrade:

- There was no significant difference in the risk of medical downgrading due to musculoskeletal disorders between Service men and women in the Royal Artillery, Royal Engineers or Royal Logistic Corps *(Table A8)*.
- Infantry Service men were at 0.68 times the risk of medical downgrade due to musculoskeletal disorders compared to Royal Logistic Corps Service men *(Table A10)*.
- Household Cavalry/Royal Armoured Corps Service men were at **0.74** times the risk of medical downgrade due to musculoskeletal disorders compared to Royal Logistic Corps Service men *(Table A10)*.
- Royal Marine Service men were at **0.53** times the risk of medical downgrade due to musculoskeletal disorders compared to Royal Logistic Corps Service men *(Table A10)*.
- RAF Regiment Service men were at **0.36** times the risk of medical downgrade due to musculoskeletal disorders compared to Royal Logistic Corps Service men *(Table A10)*.
- Royal Artillery and Royal Engineers Service men were at no greater risk of medical downgrade due to musculoskeletal disorders compared to Royal Logistic Corps Service men *(Table A10)*.
- Royal Engineers Service women were at **0.58** times the risk of medical downgrade due to musculoskeletal disorders compared to Royal Logistic Corps Service women *(Table A10)*.
- Royal Artillery Service women were at no greater risk of medical downgrade due to musculoskeletal disorders compared to Royal Logistic Corps Service women *(Table A10)*.

It is unknown how many of the unspecified downgrading codes were musculoskeletal, and further work was undertaken to verify differences in injury risk between sexes and roles across the three Services. A purpose-designed questionnaire, capturing self-reported 12 month injury incidence and medical downgrading status, was administered to a representative sample of Service personnel in GCC roles, Combat Support Roles (RE and RA), and in the RLC. Sex differences could not be evaluated because of low sample sizes, but differences between roles in men showed:

- RAF Regiment Service men were at **0.53** times the risk of new MSkI compared to Royal Logistic Corps Service men *(Table A11)*.
- Infantry, Royal Armoured Corps, Royal Marines, Royal Artillery and Royal Engineers Service men were at no greater risk of new MSkI compared to Royal Logistic Corps Service men *(Table A11)*.
- There was no significant difference in the rate of medical downgrading due to MSkI between Service men in the Infantry, Royal Armoured Corps, Royal Marines, RAF Regiment, Royal Artillery or Royal Engineers compared to Service men in the Royal Logistic Corps *(Table A11)*.

2.3.3 Outcome of Service Personnel at 4 years of Service

A similar, or lower risk of medical downgrading in GCC than in non-GCC roles in men may be due, in part, to the ***Healthy Worker Effect***, where those experiencing ill-health move out of arduous occupations. The rate of outflow and transfer of personnel across roles at 4 years of Service were, therefore, examined in the DS(H) study cohort (Section 2.1.6). Medical deployability status was also reported.

OUTFLOW FROM THE SERVICES BY SEX, TRANSFER FROM THE CORPS AND MEDICAL DEPLOYABILITY STATUS AT 4 YEARS OF SERVICE

- There was no significant difference in the risk of outflow from the Service between Service men and women in the Royal Artillery, Royal Engineers or Royal Logistic Corps *(Table A12)*.

- Royal Engineers Service women were at **2.77** times the risk of transfer from role at 4 years of Service than Royal Engineers Service men *(Table A12)*.
- There was no significant difference in the risk of transfer from role at 4 years of Service between Service men and women in the Royal Artillery and Royal Logistic Corps *(Table A12)*.
- Royal Artillery and Royal Logistic Corps Service women were at **0.82** and **0.76** times the likelihood, respectively, of being MFD at 4 years of Service compared to Service men in the same role *(Table A12)*.

OUTFLOW FROM THE SERVICES BY CORPS AND REGIMENT AT 4 YEARS OF SERVICE

- Infantry Service men were at **1.13** times the risk of outflow from the Service at 4 years of Service compared to Royal Logistic Corps Service men *(Table A13)*.
- Household Cavalry/Royal Armoured Corps Service men were at **0.94** times the risk of outflow from the Service at 4 years of Service compared to Royal Logistic Corps Service men *(Table A13)*.
- Royal Marine Service men were at **0.87** times the risk of outflow from the Service at 4 years of Service compared to Royal Logistic Corps Service men *(Table A13)*.
- Royal Artillery Service men were at **0.90** times the risk of outflow from the Service at 4 years of Service compared to Royal Logistic Corps Service men *(Table A13)*.
- Royal Engineers Service men were at **0.78** times the risk of outflow from the Service at 4 years of Service compared to Royal Logistic Corps Service men *(Table A13)*.
- RAF Regiment Service men were at no different risk of outflow from the Service at 4 years of Service compared to Royal Logistic Corps Service men *(Table A13)*.
- Royal Artillery and Royal Engineers Service women were at no different risk of outflow from the Service at 4 years of Service compared to Royal Logistic Corps Service women *(Table A13)*.

OUTFLOW BY TRANSFER FROM THE CORPS AT 4 YEARS OF SERVICE

- Household Cavalry/Royal Armoured Corps Service men were at **1.60** times the risk of transfer from role at 4 years of Service compared to Royal Logistic Corps Service men *(Table A14)*.
- Royal Engineers Service men were at **0.63** times the risk of transfer from role at 4 years of Service compared to Royal Logistic Corps Service men *(Table A14)*.
- Infantry, Royal Marine, RAF Regiment and Royal Artillery Service men were at no different risk of transfer from role at 4 years of Service compared to Royal Logistic Corps Service men *(Table A14)*.
- Royal Artillery and Royal Engineers Service women were at no different risk of transfer from role at 4 years of Service compared to Royal Logistic Corps Service women *(Table A14)***.**

MEDICAL DEPLOYABILITY AT 4 YEARS OF SERVICE

- The likelihood of being MFD at 4 years of Service was **1.10** times higher in Royal Marine than Royal Logistic Corps Service men *(Table A15)*.
- The likelihood of being MFD at 4 years of Service was **1.10** times higher in RAF Regiment than Royal Logistic Corps Service men *(Table A15)*.
- The likelihood of Infantry, Household Cavalry/Royal Armoured Corps, Royal Artillery and Royal Engineers Service men being MFD at 4 years of Service was not significantly different to Royal Logistic Corps Service men *(Table A15)*.
- Royal Artillery and Royal Engineers Service women were no more, or less, likely to be MFD at 4 years of Service compared to Royal Logistic Corps Service women *(Table A15)*.

2.3.4 Medical Downgrading Over a Career

Medical downgrading data from DS(H) reflecting the trained strength were analysed with respect to length of Service. The rate and relative risk of medical downgrading with longer length of Service were evaluated by sex and role.

- Service women were medically downgraded (including for pregnancy) significantly more than Service men during their first six years of Service *(Figure 1)*. Pregnancy accounted for ~5% of these downgradings.

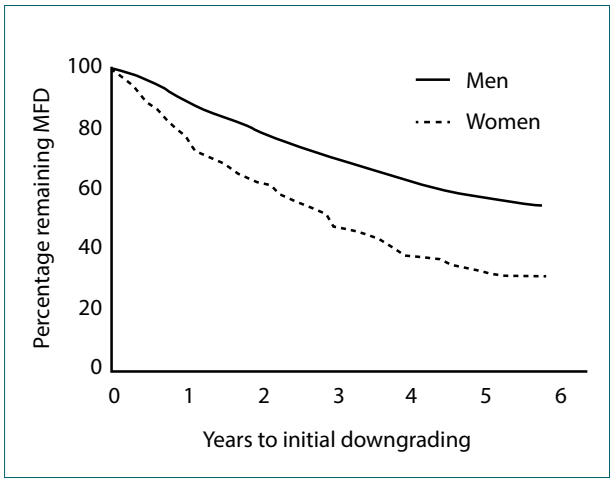

Figure 1. Rate of downgrading against length of Service in Service women and men[6]. DATA SOURCE: DS(H) study cohort.

The rate of medical downgrading in Service personnel increases with length of service

- Infantry Service men were at **1.25**, **1.15**, **1.38**, **1.51**, **1.45** and **1.93** times the risk of medical downgrading over 5-9, 10-14, 15-19, 20-24, 25-29 and 30+ years of Service compared to 0-4 years of Service *(Table A16)*.
- Household Cavalry/Royal Armoured Corps Service men were at **1.64**, **1.73**, **2.12**, **2.10** and **2.83** times the risk of medical downgrading over 5-9, 10-14, 15-19, 20-24 and 25-29 years of Service compared to 0-4 years of Service *(Table A16)*.
- Royal Marine Service men were at **1.42**, **1.41**, **2.09**, **1.99**, **3.07** and **3.26** times the risk of medical downgrading over 5-9, 10-14, 15-19, 20-24, 25-29 and 30+ years of Service compared to 0-4 years of Service *(Table A16)*.
- RAF Regiment Service men were at **2.28** and **2.27** times the risk of medical downgrading over 25-29 and 30+ years of Service compared to 0-4 years of Service *(Table A16)*.
- Royal Artillery Service men were at **1.56**, **1.59** and **1.87** times the risk of medical downgrading over 5-9, 10-14 and 15-19 years of Service compared to 0-4 years of Service *(Table A16)*.
- The risk of medical downgrading by length of Service in Royal Engineers Service men could not be calculated due to suppressed numbers of medical downgrades in trained Service personnel with 0-4 years of Service *(Table A16)*.
- Royal Logistic Corps Service men were at **1.40**, **1.77**, **1.96** and **2.03** times the risk of medical downgrading over 5-9, 10-14, 15-19 and 30+ years of Service compared to 0-4 years of Service *(Table A16)*.
- Royal Artillery Service women were at **2.01** and **2.63** times the risk of medical downgrading over 5-9 and 15-19 years of Service compared to 0-4 years of Service *(Table A17)*.

6 Rate of downgrading for women includes downgrade due to pregnancy. Only includes personnel who joined strength in the roles of interest and remained in a role of interest at the end of follow up (they may transfer roles in-between).

- The risk of medical downgrading by length of Service in Royal Engineers Service women could not be calculated due to suppressed numbers of medical downgrades in trained Service personnel with 0-4 years of Service *(Table A17)*.
- Royal Logistic Corps Service women were at **1.29**, **1.53** and **1.60** times the risk of medical downgrading over 5-9, 10-14 and 15-19 years of Service compared to 0-4 years of Service *(Table A17)*.

2.3.5 Medical Discharge

Personnel leave the Services for a variety of reasons, and medical discharge is one cause.

The rates and causes of medical discharges were sourced from DS(H), who collate and publish these data annually on behalf of Defence [5]. Reported data cover five financial years, from 2010/2011 to 2014/2015.

- Service women were at **1.47** and **1.83** times the risk of medical discharge than Service men from the Royal Navy and RAF respectively. There was no difference in the risk of medical discharge between men and women in the Army *(Table A7)*.
- The principal cause of medical discharge from the trained strength for all Services was musculoskeletal disorders and injuries [5].

Mental and behavioural disorders were the second most common cause of all medical discharge from the three Services (Royal Navy 11%, Army 14% and RAF 19%) over the period 2010/11-2014/15 [5].

Summary

In the trained strength, Service women were at greater risk of all-cause medical downgrade compared to Service men. However, despite MSkI being the leading cause of medical downgrading across all three Services, there was no significant difference in the rate of medical downgrading due to MSkI between sexes. In the training environment we observed significantly higher rates of MSkI, and medical discharge due to MSkI, in women compared to men. Although we were only able to evaluate sex differences in medical downgrade due to MSkI in the trained strength

(and not MSkI, or medical discharge due to MSkI), the lack of consistency between these data sets may reflect differences between the demands of training and employment in the trained strength. Moreover, the notion of a 'survivor' effect where only those physically robust enough to effectively manage the demands of military employment will pass through training, may contribute to this discrepancy between data retrieved from training and the trained strength.

Service men in GCC and Combat Support roles were at decreased risk of all-cause medical downgrading, or medical downgrading due to MSkI, than Service men in the Royal Logistic Corps. However, outflow data showed a significantly greater male efflux from the Infantry than from the Royal Logistic Corps, and a greater transfer from the Royal Armoured Corps/Household Cavalry than from the Royal Logistic Corps. Moreover, men in GCC or Combat Support roles were more likely to be MFD at 4 years of Service than Royal Logistic Corps Service men. These findings suggest that injured Service men in the less physically demanding occupations (e.g. Royal Logistic Corps) may be retained within their Units despite not being medically fully deployable. In contrast, men in the more physically demanding GCC roles may leave the role rather than being medically downgraded. Overall,these data suggest that women entering GCC roles may be at greater risk of outflow from GCC employment, but it is unknown how the risk of medical downgrade will differ for women entering GCC roles and attempts to understand this risk will be subject to further study.

2.4 Mental Health

DS(H) provided data on the prevalence of mental and behavioural disorders by sex and role in UK Armed Forces personnel as at 01 November 2015.

2.6% of Servicemen and 5.9% of Servicewomen are diagnosed with mental and behavioural disorders[6]. Mental and behavioural disorders are the second most common cause of medical downgrading [7] and medical discharges[5] in the UK Armed Forces.

Women had significantly higher rates of mental and behavioural disorders compared to men for all years presented. This finding is consistent with the UK general population.

Service women are at greater risk of medical downgrading due to mental and behavioural disorders than men

- Women in the Royal Logistic Corps and Royal Artillery were at twice the risk of medical downgrade due to mental and behavioural disorders than men in the same role *(Table A8)*.

The risk of medical downgrade due to mental and behavioural disorders differs between occupational role

- Male RM have **0.40** times the risk of medical downgrading due to mental and behavioural disorders than men in the RLC *(Table A18)*.

- Men in the Infantry and Combat Support (RA, RE) are at no greater risk of medical downgrade due to mental and behavioural disorders than men in the Royal Logistic Corps *(Table A18)*.
- The risk of medical downgrade due to mental and behavioural disorders is similar for women in Combat Support (RA) and Combat Service Support (RLC) roles *(Table A18)*.

Service women report, and are diagnosed with, mental and behavioural disorders more frequently than men

Service women report significantly[6] more mental and behavioural disorders to the medical chain than Service men *(Figure 2)*.

Service women are 1.07 (95% CI 1.06-1.09; P<0.001) times the risk of mental and behavioural disorders diagnosis on referral than Service men.

Service women are diagnosed with significantly higher rates of depressive episodes, adjustment disorder and other mental health disorders than men[8].

Service women who had previously deployed to Iraq and/or Afghanistan had significantly higher rates of mental health disorder compared to Service men deployed on similar operations. However, previous deployment to Iraq and/or Afghanistan was not a predictor for mental health disorders among UK Servicewomen[8].

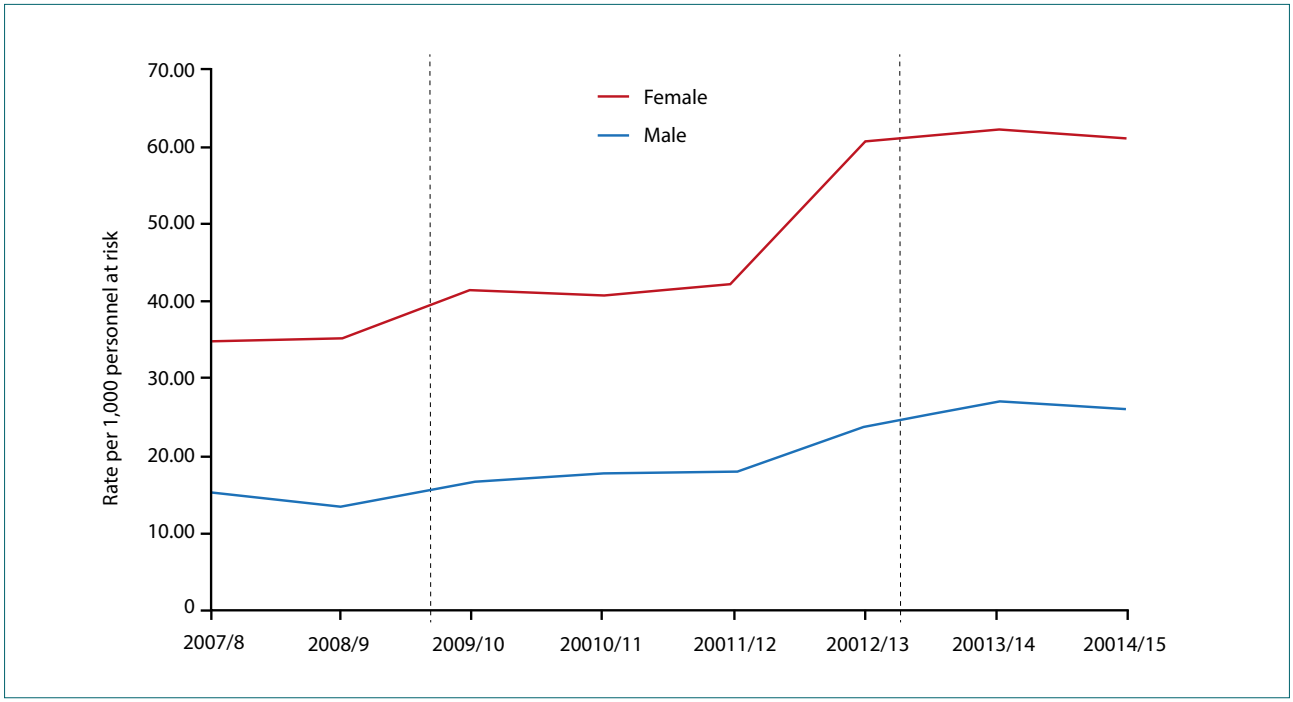

Figure 2. Rates (per 1000 personnel at risk) of UK Service personnel assessed with a mental disorder at a MOD Department of Community Mental Health by sex between 2007 and 2015. Vertical lines denote changes to reporting methods introduced in 2009/2010 and 2012/2013.

Summary

Service women were more likely to present in primary health care with mental and behavioural disorders compared to Service men. This finding may be due women having different health seeking behaviours than men [9, 10], or that men present less even in the presence of pathology. However, on referral to the Department of Community Mental Health, women were more likely to be diagnosed with a mental or behavioural disorder and were more likely to be admitted for in-patient mental health treatment [11]. Therefore, female sex may be a risk factor for developing a mental health disorder.

Service women had significantly higher rates of depressive episodes, adjustment disorders and other mental health disorders than Service men. However, there was no evidence from the currently available UK data that women were more at risk of Post-Traumatic Stress Disorder (PTSD)[6], and overall only 0.2% of the UK Armed Forces population were assessed as having PTSD [6].

A review of all the literature of US female soldiers/veterans and PTSD [12] identified seven studies that reported women with a higher risk of PTSD, seven studies showed no difference, but four studies found that women had a reduced risk of PTSD than men. The studies reporting a reduced risk of PTSD in women than men used the same source databases, were conducted in treatment-seeking populations, and were mostly unable to account for combat experience. Studies reporting an increased risk of PTSD risk was supported by a large dataset from the US Military Millennium Cohort showing that women were at higher risk of PTSD, depression, anxiety and eating disorders but at lower risk of alcohol abuse [13]. Women were likely to be less exposed than men to combat trauma during the data collection period, due to the exclusion of women in GCC roles and, therefore, this may indicate a potentially increased risk of PTSD in the US Armed Forces female population.

In a representative sample of the UK Service personnel [14] women scored higher overall on the PTSD checklist than men, although affected men were more likely to score symptoms as extreme. Women reported more common mental disorders, such as anxiety and depression, but men reported more alcohol misuse. The authors concluded that the impact of deployment on mental health is similar in men and women, however, the findings from the US would indicate that further bespoke work should be undertaken in UK Service personnel, standardising exposure to traumatic events to understand whether female sex is a risk factor for PTSD.

2.5 Reproductive Health

Overview

The demands of Service life are unique, particularly for GCC roles where the job requires high levels of fitness to sustain force preparation and operational deployments. Dismounted soldiers, in particular, are often referred to as the ***tactical athlete*** because of the fitness requirements to perform these roles. Arguably, GCC personnel face additional challenges to the athletic population where the opportunity for sufficient recovery from the physical burden of training exercises and operations is often restricted by the priorities of mission success. Inadequate nutrition (through lack of time, menu fatigue, or poor eating habits) and sleep, and smoking also separate the practices of dismounted Service personnel from athletes.

The impact of GCC demands, be it training exercises or deployment, on health has received some attention in men. We have previously reported marked losses in body mass of soldiers following arduous Infantry courses at the Infantry Battle School, corresponding to inadequate energy intake [15]. Additional feeding with snacks and hot meals prevented decrements in physical performance and reproductive hormones (total testosterone) [16], and protected markers of immune health [17]. A recovery in free testosterone from mid-operational decreases have also been reported in men without clinical effects [18].

Failure to maintain or restore energy availability may have a greater impact on the health of women than of men because of the essential role of energy to maintain female reproductive function. In the face of low energy availability,

the body downregulates or 'shuts down' the signalling pathway between the brain and reproductive organs to prioritise energy supply to vital organs, including the brain. Over time, reproductive hormones decline, menstrual periods become irregular or eventually stop and the loss of protective effects of oestrogen can impair bone health. This clinical syndrome has been recognised for some years in female athletes who experience eating disorders, osteoporosis and amenorrhoea (absence of menstrual periods), described as the Female Athlete Triad [19].

The Female Athlete Triad

The few studies that have explored the existence of the Female Athlete Triad in female military personnel have not observed all three components in either female trainees or in active duty female soldiers despite a high prevalence of those 'at risk' of eating disorders (33.6%) [20]. However, functional hypothalamic amenorrhea and osteoporosis are not necessarily clinical endpoints in revised paradigms of the Female Athlete Triad [21], and the physiological and clinical consequences of low energy intake include menstrual dysfunction [22], impaired bone mass and microarchitecture [23], and increased through-career risk of fracture [24].

The underpinning aetiology of the Female Athlete Triad, ***low energy availability*** [25], has clinical implications for women in GCC roles for two main reasons. First, soldiers experience restricted energy intake for some months during physically demanding training or on operations. This restricted energy intake might be unintentional, when energy expenditure is high and a shortfall in energy intake ensues [15], or deliberate energy restriction such as during US Ranger training [26]. Second, the prevalence of eating disorders in US female military personnel is higher than population estimates [27], and deployed women exposed to combat are at greater risk of new-onset disordered eating and greater weight loss than their non-exposed deployed counterparts [28].

Occurrence of Fertility Problems in Service women

We conducted an initial audit[7] to establish the occurrence of fertility problems in British Service women *(Table A19)*. Our cohort included all Regular, trained Service women of reproductive age (15 to 49 years) registered on DMICP between 1 January 2013 and 31 December 2015. This reporting period excludes data recorded before changes to DMICP registration status in mid-2012. Age-stratified data were extracted from anonymised individual health records held in the DMICP data warehouse, and sorted by unique identifier and date of clinical event. The Read codes selected for this audit were matched with those used in a large scale, retrospective study of the occurrence of fertility problems in the civilian population [29] for comparison purposes. We could not include drug prescriptions used exclusively to treat infertility since infertility medications are not available from the tri-Service Formulary, and excluded other possible relevant codes, which may possibly have accounted for a 25% underreporting in Service personnel. Where more than one clinical event was recorded in the reporting period, only the first recorded event was included to reflect period prevalence. The denominator used was a mid-year female trained Service personnel population as on DMICP at the end of June for each year in the study, stratified by age for the relevant years. The denominators from this method of data collection were compared with mean female trained Service personnel population data retrieved monthly over a calendar year to ensure that this was an appropriate method.

7 This audit was registered with the Medical Director's Office.

Summary

The rate of fertility problems in the military *(Table A19)* appears to be higher than is reported in an age-matched civilian population [29]. However, we have not performed a statistical comparison of the risk of fertility problems between a military versus the civilian population due to differences in data capture.

This audit gives no indication of causation, and did not control for confounders such as separated Service, chlamydial infection or changes in health behaviours due to policies such as the NHS clinical commissioning policy "Assisted Conception" for the Armed Forces. Dhalwani et al [29] reported a modest increase in overall rates of fertility problems after 2005, which may reflect changes to UK NHS policy for better access to infertility treatment during the study period. This change in policy may have affected the rates presenting per year in the UK population for the same time period (2013-2015), possibly more so for the older age groups. Additionally, our data did not capture Service women who did not consult their military GP with fertility problems.

No data are presented for men since no comparable rates were available in the civilian population. However, recent evidence evaluating the demands of arduous deployment and reproductive signalling in men [18] suggest that temporal changes in free testosterone, the principal reproductive hormone involved in spermatogenesis, recovers rapidly. The apparent reversible effects of arduous training on the reproductive axis in men may be the same in women.

Dhalwani *et al* [29] applied the Lexis expansion to account for an aging population over their reporting period of 20 years. Our data were only collected over a 3 year period, and around 94% of the study population did not change age-group bracket during this time. Therefore, performing a Lexis expansion was deemed to add no further value at this time. Dhalwani *et al* also presented data by Townsend Deprivation Index in their study. Postcode is often used as a surrogate for deprivation. Whilst this method is not applicable for Armed Forces Personnel, the underlying definition of measures of material deprivation (unemployment , non-car ownership, non-home ownership, household overcrowding) described by Townsend [30] suggests that Armed Forces Personnel may be considered as equivalent to Quintile 1 i.e. the least deprived.

Overall, these findings warrant detailed prospective investigations into the possible causes of fertility problems. Particular consideration should be given to the Female Athlete Triad, which we believe may contribute to an increased risk of impaired bone health and stress fracture injury, and possibly fertility problems, in women entering GCC roles because of the unique demands of training for, and operating in, combat.

3 What are the Mitigations for Women in Ground Close Combat Roles?

We have shown, that musculoskeletal and/or mental and behavioural disorders are the principal health risks to Service women either during initial training and/or in the trained strength of the Armed Forces. The increased risk of medical downgrading and medical discharges is not likely to result from sex differences in health reporting behaviours alone. We can reasonably expect injuries and mental health disorders to present a similar, if not increased risk, for women in GCC roles because of the significantly higher demands of preparing for, and operating in, combat alongside men ***unless*** appropriate mitigations are in place. The true extent of these risks will not be known until women serve in GCC roles.

Based on our evidence, we have identified four mitigation strategies considered ***essential*** if the restriction of women in GCC roles is lifted in 2016. Three of these mitigations are designed to prevent musculoskeletal injury risk and enhance physical performance. Musculoskeletal injuries are likely to have the biggest impact on deployability and military readiness because of the likelihood and volume of injuries that are sustained, and the consequences of medical downgrading and medical discharge. Increased injury risk to women in GCC roles will also add to the significant financial burden of injuries, which is projected to cost the Army £1.202 billion over the next 15 years[8].

Immediate mitigations to protect against mental health disorders, which may be worsened by combat exposure, must also be adopted possibly by utilising existing strategies developed for operational stress (Mental Health First Aid).

Physical Performance and Injury

- Development of Physical Employment Standards.
- Implementation of optimal physical training strategies.
- Interventions for injury prevention.

Mental Health

- Mental Health First Aid.

3.1 Development of Physical Employment Standards for GCC Roles

Physical Employment Standards (PES) are utilised by employers to select and train personnel based on the physical requirements of the job, with the aim of achieving an optimal 'job-person' fit. Defensible PES must be free of discrimination on the grounds of a protected characteristic, such as sex or age; must reflect the essential physical tasks required to perform the specified job successfully; and, must use pass standards that reflect the minimum physical performance standards required to safely and satisfactorily complete these essential job tasks. For these reasons, adherence to internationally agreed scientific frameworks for the development and implementation of PES is strongly recommended [(31)].

At present single Services mainly use vocational tests to assess the annual fitness of personnel[9], which tend to be either outdated or not formally validated against job requirements. There is an urgent requirement to develop and implement evidence-based PES for tri-Service GCC occupations in support of a defensible decision to lift the restriction of women in GCC roles, and there is a clear lag behind other Nations (e.g. New Zealand, Australia, US and Canada).

8 For pension and personnel costs alone. Reference: ArmyHQ/Res/MAS(A)/Projects/1-062 dated 23 Mar 16.

9 Army - Annual Fitness Test (AFT); Royal Marines Combat Fitness Test (CFT), Basic Fitness Test (BFT) and battle swim test; RAF Regiment - CFT, RAF Annual Fitness Test (RAFFT) and a swim test.

By doing so, we will:

a. Mitigate the risk of musculoskeletal injury.

b. Ensure that individuals have the physical capability to meet force preparation and operational requirements.

c. Satisfy the requirements of UK legislation [32, 33].

The WGCC Review team has commissioned the University of Chichester, through the government framework Defence Human Capability Science and Technology Centre (DHCSTC), to develop PES that reflect the physical requirements of GCC roles optimally (reference TIN 3.179).

Methods

The methodology for this work has been adopted from recommended PES frameworks [34, 35], experiences from other Nations, and legal precedent. A tri-Service PES Technical Working Group (PES TWG) of Subject Matter Experts has been established to provide assurance for our GCC PES methodology through the life of the programme.

After consideration of best-practices, PES TWG endorsed the following four-phased work programme, illustrated in *(Appendix C)*[10].

a. Phase 1 - Identify 'essential' GCC tasks;

b. Phase 2 - Endorse the identified 'criterion tasks' for GCC roles and conduct an observational/physical demands analysis of these tasks;

c. Phase 3 - Develop and validate occupational fitness tests;

d. Phase 4 - Develop and validate selection-based fitness tests.

The GCC roles have been subdivided into 10 categories as recommended by the WGCC Review team in consultation with Director of Combat *(Table 1)*.

Table 1. Categories of Ground Close Combat Roles

	Category	GCC Role
1	Heavy	Armoured Regiment
2	Medium	Armoured Cavalry
3		Armoured Infantry
4		Mechanised Infantry
5	Light	Light Cavalry
6		Light Mechanised Infantry
7		Royal Air Force (RAF) Regiment
8		Light Infantry
9	Light+	Air Assault Infantry (Parachute Regiment)
10		Commando (Royal Marine)

The output of Phase 1 identified 180 'essential' physically demanding tasks across 10 GCC roles. The tasks have been allocated into 18 generic Task Categories *(Table 2)*, listed by the number of times reported by serving personnel across a representation of ranks.

10 The timing for contractual delivery of this work programme is subject to further work.

Table 2. Categorisation of the 180 'essential' tasks.

Task Category	n	Example Tasks
Movement on Foot	33	Tabbing, Patrolling, Ski March, Speed March,
Preparing Positions	20	Establish a Harbour Area, Construct an OP
Vehicle Maintenance & Repair	16	Replace CR2 Track, 30 mm Gun Maintenance,
Equipment Prep & Loading	15	Re-supply Infantry AFV, CR2 Vehicle Preparation
Operations in Vehicles	14	Road Movement in CVR(T), Amphibious Transit
Fire and Movement	16	Platoon Attack, Flight Battle Drills
Casualty Drag	10	Casualty Drag
CASEVAC by Stretcher	10	CASEVAC by Stretcher/Improvised Stretcher
CASEVAC on Foot	9	CASEVAC to Point of Extraction, Fireman's Carry
Urban Operations	8	Break In, Building Clearance, Urban Operations
Vehicle Recovery	5	Vehicle Recovery
CASEVAC from Vehicle	6	CASEVAC of Driver, CASEVAC from a Vehicle
Other Tasks	5	Counter IED Search, Recce Raid, Vertical Assault
Ceremonial Duties	4	Drill, Yard Prep
Public Order	3	Public Order
Maintain Stag	2	Maintain Stag, Sentry Duty, on exercise
CTR	2	CTR
Swimming	2	Swimming, River crossing

Notes: Where: n is the total number of time the tasks were identified in the focus groups tasks; OP is Observation Post; CR2 is Challenger 2 main battle tank; AFV is Armoured Fighting Vehicle; CVR(T) is Combat Vehicle Reconnaissance (Tracked), CASEVAC is Casualty Evacuation; IED is Improvised Explosive Device; CTR is Close Target Reconnaissance.

Initial results indicate that prolonged movement on foot, preparing positions and vehicle maintenance are the most frequently cited tasks performed by GCC personnel. Moreover, a breakdown of the proportion of physically demanding tasks performed by all GCC roles involve all physical fitness components of aerobic, anaerobic, muscle strength and muscle endurance (Figure 3), which can be used to target physical training strategies for women (and men) in GCC roles. Subsequent physical demands analysis in Phase 2 of the work programme will establish the physiological burden of the tasks identified for each GCC job role.

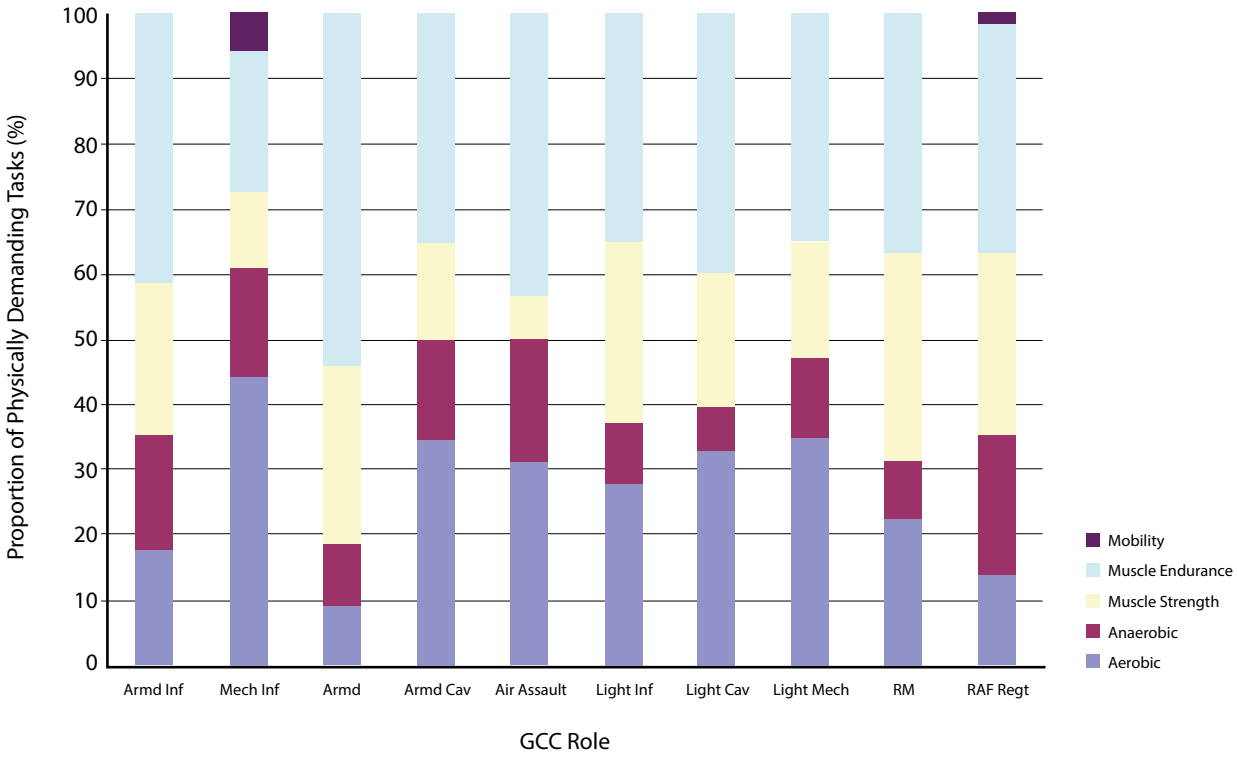

Figure 3. The physical fitness requirements of GCC tasks expressed as a proportion (%) of all physically demanding GCC tasks for each GCC role.

Summary

The development and implementation of valid and optimised occupational standards is a robust mitigation strategy that will benefit ***all*** Service personnel selected, trained, and retained in GCC roles.

Matching the physical performance of personnel to the physical demands of a role will improve health and safety (e.g. reduced musculoskeletal injuries) and productivity (e.g. optimising operational effectiveness).

The potential benefits of this programme will not be delivered until 2018 and into 2019 due to the scale and complexity of this work. Interim solutions for PES are in development, and optimal physical training injury prevention strategies will play an essential role in mitigating the risk of women serving in GCC roles.

3.2 Physical Training Strategies for Women in GCC Roles

Background

The biggest physical challenge that women will face in GCC roles is the requirement to lift and carry heavier loads over longer distances in training and in combat than they likely do in their current roles. A task analysis of all military occupations in the British Army carried out between 1993 and 1998 showed that lifting, carrying and marching are the most common tasks that military personnel are required to do, and that GCC roles have to achieve the highest physical standards on each task [36].

Far fewer women than men will be able to achieve the physical standards of GCC roles because of their lower aerobic and anaerobic fitness, muscle strength and power.

The gap in physical performance is typically between 20 and 50%, with the biggest differential in upper body strength. We have previously reported that only 4.5% of female Army candidates are able to achieve the extant physical entry standards of Infantry roles, limited mainly by the 40kg single lift performance underpinned by upper body strength [1].

The physical requirements for performing GCC tasks also extend beyond achieving task-based assessments. Women must also be prepared to withstand the physical burden of wearing Personal Protective Equipment (the current in-Service helmet, weapon and body armour weigh approximately 13kg) and marching loads of 40kg for sustained periods. We ***must***, therefore, train and prepare women adequately for the demands of GCC roles by employing optimal training methods designed to target specific occupational demands. Traditional military physical training practices are not suitable for preparing women for the rigours of combat where training is conducted in large groups and to the standard of the weakest individual. Given the inherent physiological differences between women and men, the potential improvements in the physical performance of women with appropriate training are ***essential*** considerations in the decision of employing women in GCC roles.

Trainability of Women for GCC Roles

The trainability of women for occupational task performance has been explored in three key studies previously commissioned by the US Defense Women's Health Research programme [37]. Overall, the studies demonstrate that training programmes of untrained women, adopting scientific training principles of 'training individualisation', 'specificity' and 'overload', elicit significant improvements in key tasks such as lifting and load carriage [38]. The improvements are operationally relevant in that more than three times the number of women met the standards for 'very heavy' military occupations following training [38], and that all women were able to achieve the same load carriage abilities as untrained men [39] following properly designed training programmes.

Training adaptations continue at 6 months, indicating that women may require more time to reach their full training potential. Since these performance gains can be achieved in 3 to 4 sessions per week, the administration of training programmes can be delivered in the time typically allocated to military physical training. However, given the competing demands and extant large physical training requirement of initial military training courses, the addition of a specific strength training programme to the already busy schedule would need to be carefully managed, and may be best placed outside the training environment. Optimal training for strength and power requires heavy resistance training to generate high muscle forces and increase the volume of muscle tissue; governed by both neural and growth factors. Reliance on women's own body mass for resistance will not achieve the same gains in strength and power as heavy lifting, challenging conventional delivery of military PT for women in GCC roles.

Periodised, progressive strength training programmes are recommended for women to achieve optimal gains in strength and power, necessary for successful performance of GCC roles. The periodisation of training refers to the variation in exercise intensity, volume, type and load, combined with varying duration and frequency of rest periods, over a given period of time to achieve short- and long-term training goals [40]. A progressive training programme refers to the graded increase in exercise intensity and load which allows for musculoskeletal adaptation and graded overload. The combination of periodisation and progression not only optimises training adaptations, but also protects against injury by allowing sufficient recovery time and promoting a gradual increase in exercise intensity. Arguably the greatest challenges to incorporating a strength training programme of this nature are resources (appropriately trained personnel to deliver the programmes and equipment), maximising recovery time to promote optimal adaptation and reduce injury risk, and the time within existing physical training programmes to effectively incorporate these competing demands. If women are to be successfully integrated into GCC roles, PT needs to be ***prioritised*** through-career.

Training for Load Carriage

Load carriage is an essential task in GCC roles, which may not be limited to long distance marching. GCC personnel might find themselves sprinting or performing casualty evacuation under loaded conditions. The loads carried by GCC personnel are particularly injurious [41] and we might expect women to be even more susceptible to injury from exposure to the demands of GCC roles.

Optimal load carriage ability relies on all components of physical fitness. A combined strategy of progressive resistance training with aerobic training, with a specific emphasis on load carriage exercise, conducted at least 3 times over 4 weeks has been demonstrated to be most effective for improving load carriage performance [42]. When resistance or endurance exercise training is performed in isolation, the resulting effects on load carriage performance are smaller and more variable [42]. Therefore, progressive resistance training must be suitably combined with aerobic training to improve load carriage performance. To achieve training specificity, load carriage training must also reflect the loads, distances and intensity of exercise experienced on operations to target the muscle groups and energy systems used, to maximise load carriage performance and minimise the risk of injury through-career.

Summary

The optimal preparation of women for GCC roles requires a detailed understanding of the specific occupational demands of GCC specialties. This understanding will evolve from the process of developing updated, valid GCC PES.

Delivery of properly designed training programmes, with special consideration given to maximising total body strength using heavy resistance exercises, must be considered in the decision of women's employment in GCC roles.

Women will be less susceptible to physical injuries with appropriate, targeted evidence-based physical training.

The military should continue to invest in better equipment, adequate resources and training time to prioritise PT and maximise the physical performance of women in GCC roles

3.3 Injury Prevention Strategies for Women in GCC Roles

Background

Musculoskeletal injuries (MSkI) are the biggest challenge to personnel in the Armed Forces. This risk of MSkI occurs early in a military career, and is responsible for the majority of trainee and trained strength medical discharges. Injuries in initial training are mainly ***overuse*** in nature, caused by the cumulative effects of training. Overuse injuries often require lengthy periods of rehabilitation [43], which are significant to both the individual and organisation. Acute injuries caused by tripping or falling account for around 30 to 35% of all training injuries, but still require prolonged treatment in some cases (e.g. ankle sprains [43]).

Women are more susceptible to MSkI than men. Lower levels of physical fitness, lower muscle mass and a smaller skeleton of women increase the stress on the soft and boney tissues under loading. Women typically injure on a 2:1 basis compared with men. The risk of injury to women increases on more arduous courses, such as the commissioning course for Officer Cadets. The frequency of MSkI is also much higher in Infantry trainees than in male Standard Entrants on less physically arduous courses. The duration, intensity, and loads carried in training for GCC roles are arguably most rigorous of all initial training courses.

Women are particularly at much higher risk of developing stress fracture injuries from 'over-exercising' than men; their smaller bone size increases bending stresses from axial loading, and a smaller muscle mass is less able to protect bone from impact with the ground. Carrying heavier loads at a quicker pace in training for GCC roles is likely to increase the risk of stress fractures in women further still, and this additional stress from the demands of GCC training is evident from the increased risk of stress fracture injuries we see in Infantry compared with male Standard Entrant trainees.

Women and Infantry trainees alike are prone to hip fractures from a smaller skeleton and higher stresses from arduous training, respectively. Hip fractures are debilitating injuries that take a long time to heal. We believe that the combined risk of ***women*** undertaking ***Infantry*** training must be carefully considered in the decision to lift the restriction of women in GCC roles.

Maximising physical performance with specific progressive training methods is key to preventing MSkI, but the opportunity for prioritising individualised training programmes is fairly limited in initial training environments because of the competing demands of the course. Many local initiatives at individual training Units are undertaken to reduce the risk of injury prevention, but enduring training policy is best underpinned by robust scientific evidence. We conducted a systematic review to identify putative strategies designed to mitigate against the risk of MSkI in trainees.

Overtraining

The breakdown of muscle and bone with exercise is an important adaptive process to achieve performance gains and for tissues to become more efficient and/or stronger. However, this exercise 'overload' if coupled with inadequate recovery will result in overtraining and increased injury risk. Initial training is typically a busy programme of physical activities such as marching, field/exercise craft, formal physical training sessions, and drill practise. For many, the balance between exercise 'overload' and overtraining is not achieved, and tissues fail to recover from the constant, and often new, physical demands of training. Although this balance is difficult to achieve, the high rates of MSkIs reported during initial military training are likely exacerbated by this lack of appropriate balance between training stimuli and recovery time.

Interventions with the strongest evidence for reducing injury risk are those that prevent overtraining caused by distance running. Distance running is a traditional and common training activity for cardiovascular fitness in the military, but excessive mileage is a significant risk factor for overuse lower limb injuries during initial training [44]. Several intervention studies conducted in the US, Swiss and Australian Armies during initial military training have demonstrated beneficial effects of reducing overall running mileage on injury rates and attrition from training [45, 46]. Interventions included substituting long duration distance runs for weighted march activity [45], a combined programme of conditioning, running and flexibility training [45, 46], an adapted programme of high-intensity interval runs, functional strength circuit training and balance training [47], and reducing distance on foot by using vehicle transportation to exercise grounds [47]. Injury rates (trauma, overuse and lower limb) were 20 to 52% lower [45, 46], and attrition 53% lower [47] in the groups performing the adapted activities compared to those completing long duration distance runs. Importantly, these adaptations did not blunt performance gains and were effective in both men and women [45]. A reduction in running mileage, combined with reduced march speed and promotion of individual step length, has also been shown to reduce pelvic stress fracture injuries in female recruits [48]. Although these adapted interventions appear to have clear benefits for women in initial training, the utility of these interventions for women in GCC roles who will operate alongside men on training exercises, on promotional courses, and on operations may be more limited.

Of note, the combined intervention of reducing distance on foot during the first 4 weeks of training, and performing the adapted training programme of high-intensity interval runs, functional strength circuit training and balance training during the first 10 weeks of training was more effective

than either intervention alone [47]. These two interventions likely target different mechanisms of injury prevention, with reducing prolonged running decreasing overuse injuries, and the adapted training programme reducing trauma injuries [47]. The mechanisms of MSkI are important considerations when developing and implementing injury prevention strategies.

Sex-specific considerations

Recruits with lower physical fitness are at greater risk of injury [49, 50]. Training individuals in similar ability groups during initial training can optimise training benefits for individuals at all levels of fitness and reduce injury risk. Since women have lower levels of aerobic fitness, are at higher risk of injury, and experience 27% greater cardiovascular strain than men during training [51] , training recruits in single sex platoons is a logical option to reduce overtraining. The British Army has trained Standard Entry men and women in single sex platoons since 2006. This training method allows female trainees to train at the same relative intensity, and achieve the same fitness gains, as men, while experiencing fewer overuse injuries (2). Other strategies such as standardising total exercise time rather than total distance may be useful for preventing overtraining and reducing injury risk of mixed ability groups, while still allowing each individual (from the least to most fit) to effectively adapt and improve performance [44].

Conditioning

Exercises to improve core strength, flexibility and balance are becoming popular efforts to prevent injuries in initial training environments. The addition of multiaxial, neuromuscular, proprioceptive and agility conditioning exercises to initial training has previously been recommended [44], but we fail to support this exercise intervention based on our recent review of both the military and athletic literature where the evidence-based was shown to be inconsistent.

The most effective aspects of conditioning programmes, including optimal length, frequency and exercise type need to be investigated further to more conclusively establish their possible utility for military-specific fitness and injury prevention.

Footwear modifications / bracing

Inappropriate fit of footwear is a risk factor for overuse injuries [52]. However, our review does not support the use of orthoses [53, 54] or prescription of running shoes based on plantar shape [52, 55] as effective injury prevention strategies. Issue of military boots prior to training may be beneficial for improving comfort and aiding injury prevention, a practice adopted by some UK initial training organisations.

Preliminary indications that women may benefit more from orthotics added to military boots than men [56] may warrant future attention.

Certain activities, for example military parachuting, are associated with acute trauma injuries, e.g. ankle sprains. Ankle bracing is considered effective for reducing ankle injuries during military parachuting[57], without transferring injuries to other lower limb regions, and may be beneficial for other similar high-risk activities.

Leadership / supervision / awareness

Effective leadership, achieved through education of military leaders and leadership support, Unit injury surveillance and adequate resources for injury research and programme evaluation, should be considered ***essential*** elements of injury prevention efforts [44]. Effective leadership and injury surveillance have been shown to be effective in decreasing femoral neck stress fractures in male (by 38 to 60%) and female (by 48 to 56%) US Army recruits [58]. A multi-interventional approach to injury prevention in initial training is strongly recommended for the safe integration of women in GCC roles.

Summary

Initial training of women in GCC roles presents a very high risk of debilitating injuries. Stress fractures of the hip present a significant risk to women, and to Infantry trainees.

The combined strategies of increasing physical fitness and minimising 'time on foot' are likely to benefit acute and overuse injury prevention efforts.

Mixed evidence means it is unclear if multiaxial, neuromuscular, proprioceptive and agility conditioning programmes reduce injury risk. The most effective components of conditioning exercise programmes for reducing injury risk and optimising performance need to be established.

Ankle bracing appears to be an effective injury prevention strategy in military parachuting cohorts, and does not transfer injuries to other lower limb regions. However, this positive effect may be less apparent for preventing ankle sprains during typical initial training activity.

The protective effect of modifying footwear is unclear. There is a preliminary indication that women may benefit more from wearing insoles during military Officer training and this finding warrants future attention.

Benefits of single sex training include reductions in female overtraining and injury risk, potential for a more appropriate progressive, gradual increase in training load for women and scope for greater performance gains in both men and women.

Good leadership / supervision / awareness are essential elements of all injury prevention strategies.

Interventions to prevent overtraining and improve physical robustness are essential considerations for training women in GCC roles

3.3.1 Postpartum Injury Risk

Certain sex-specific issues need to be considered in lifting the restriction of women in GCC roles. One such issue concerns pregnancy and specifically the postpartum period (up to 12 months after pregnancy). Pregnancy gives rise to several significant physiological changes including; weight gain, changes in breast tissue, increased cardiac output and stroke volume, increased ligament laxity, and decreased bone mineral content [59]. The temporal pattern of these physiological changes postpartum, especially with maternal lactation, is unclear. Moreover, the impact of these physiological changes on injury risk, health and physiological performance is relatively unknown. Given women are more at risk of overuse injuries, and in particular stress fractures, than men, the potential further impact on bone health from pregnancy means that specific postpartum mitigations may need to be considered.

There is some evidence in a matched case-control study that working days lost per week due to illness alone, and

a combination of illness and injury, were significantly higher in UK Service women during the postpartum compared with pre-pregnancy period [60]. 50% of injuries in postpartum women were back and neck injuries. The risk of injury may be higher still for women returning to arduous duties in GCC roles.

The National Health Service advises women to breastfeed for six months. Adjusted bone mineral content only recovers at 24 months in lactating women compared to 3 months in non-lactating women (mean duration of breastfeeding 345 +/- 177 d) [61]. More than 73% of women in the UK now start breastfeeding.

Ministry of Defence policy on maternity (JSP 760) states that a Service woman may take 26 weeks ordinary maternity leave but that only two of those weeks are compulsory. In addition, parental leave can now be shared. Women may therefore be returning to work in GCC roles between two weeks and six months postpartum while still breastfeeding. Although each woman returning to work will undergo a medical assessment, there is no policy guidance for medical officers on the physiological considerations of returning to work following childbirth. Given the potential implications for bone health in the postpartum period, postpartum return to work policy needs to be re-evaluated.

Mitigations

Consideration should be given to assessing fitness for return to full duties based on whether a woman is actively lactating or when lactation ceased. This assessment would primarily consider whether the skeleton has returned to its pre-pregnancy state and when ligament laxity has been resolved. These changes are likely to be between 12-24 months post-lactation.

A postpartum rehabilitation programme may be useful to assess an individual's ligament laxity and allow an individual to return to full fitness in a graduated way as advised by the Royal College of Obstetrics and Gynaecology [62].

3.4 Mental Health and Behavioural Disorders

There is little evidence of interventions that prevent occupational stress, detect early signs of mental ill-health, or of how efficacious they are in men and women in military populations. Perceived levels of cohesion, morale and good leadership were associated with lower self-reported levels of common mental health disorders and PTSD in UK Armed Forces deployed to Afghanistan in 2010 [63]. Good leadership was defined by statements such as; "leaders who seldom or never embarrassed their subordinates", "seldom or never accepted extra duties to impress", "often or always treated their subordinates fairly", or "always showed concern for their subordinates". Good leadership may, therefore, in itself be protective and this should be re-enforced in leadership training.

A high degree of psychological resilience is thought to be protective for occupational stress and mental ill-health. Psychological resilience is defined as the "capacity to adapt successfully in the presence of risk and adversity" [64]. Resilience and mindfulness training is promoted by other nations, but a recent review did not support the implementation of any such programmes [64].

Whilst the WGCC research programme will address the knowledge gaps in the risk factors for increased propensity for mental and behavioural disorders in Service women, a mental ill-health intervention currently used by the MOD is Mental Health ***First Aid*** training (MHFA). MHFA is part of an international movement, building mental health (MH) awareness in communities. MHFA for the Armed Forces is a specially designed course that provides trained instructors with the tools to promote and increase MH awareness amongst serving personnel. The Armed Forces MHFA course focuses on military culture. Adopting this course allows for increasing early intervention, faster recovery and encouraging self-help strategies, leading to improvements in mental health across the wider Armed Forces. Increased awareness of mental health issues in personnel supporting women in GCC roles will help early recognition of deteriorating mental health.

4 Conclusions

This interim report highlights the risks to women should the restriction to women in GCC roles be lifted, and include in brief:

1. The disproportionate risk of musculoskeletal injuries to women in Infantry training. Notably, the propensity to debilitating hip injuries requires special consideration if women are to successfully undertake Infantry training and/or GCC employment.
2. The increased likelihood of medical downgrading at an earlier stage of a woman's career; consideration should be given to how this risk will be managed for GCC employment where the physical demands are likely to be much greater than Service women are currently exposed to.
3. Susceptibility of women to mental ill-health; it is not known how mental ill-health would be affected by Service in GCC roles but consideration needs to be given to the potentially increased psychological demands of GCC employment.
4. The potential risk to female reproductive health from arduous military training. However, further understanding of this potential risk is required.

The issue of women serving in GCC roles challenges the balance between the right to equality and duty of care. There are immediate mitigations that can be introduced for musculoskeletal injuries and possibly mental ill-health. In the absence of validated GCC PES until 2019, ***health surveillance*** of the low number of women likely to enter GCC roles will flag early signs of injury and ill-health for immediate clinical assessment. The underpinning causes of impaired musculoskeletal, mental and reproductive health, and development of bespoke mitigations for women in GCC roles, will be addressed in the remaining research programme, which will also benefit Service men.

5 Recommendations

1. New optimised Physical Employment Standards for GCC roles are implemented.
2. Optimal, progressive physical training strategies, with special consideration for upper body strength and load carriage performance, are delivered ***through-career*** for women (and men) in GCC roles.
3. Interventions to reduce ***overtraining*** (e.g. excessive distance running) are introduced.
4. Initial training is undertaken in a single sex manner.
5. Women in GCC roles are monitored through-career for early signs of injury and/or ill-health by an occupational physician.
6. Education on injury risk, ill-health, and preventative strategies is provided to all leaders and personnel.
7. Provision of, and access to, Mental Health ***First Aid*** is made available and strongly encouraged at Unit level.
8. Education on appropriate training, postpartum requirements, and dietary needs for women in GCC roles is provided in an updated 'Servicewomen's Guide'.

Research is continued to identify the causes of injuries, mental ill-health, and impaired reproductive health so that that bespoke mitigations can be developed for the UK Armed Forces population.

6 | Risks and Risk Mitigations

In this section, we summarise our judgement of the risks to women in GCC roles, based on the relative risks of current Service personnel.

Risk 1:

Women ***training*** in GCC roles will be at medium to high levels of musculoskeletal injury risk. Specifically, women in GCC roles will be at:

- ***Medium*** risk of medical discharge due to musculoskeletal injuries, particularly of the lower limb.
- ***High*** risk of medical discharge due to hip injury.
- ***High*** risk of sustaining stress fracture injury.
- ***High*** risk of hip/pelvic stress fractures.
- ***Medium*** risk of suffering hip/thigh injuries.

Mitigations:

Prevent overtraining.

Implement validated Physical Employment Standards.

Implement properly designed physical training methods.

Revise postpartum return to work strategies for women in arduous roles.

Risk 2:

Women operating in GCC roles will be at ***increased*** risk of mental health and behavioural disorders.

Mitigations:

No evidence-based mitigations available.

Mental Health ***First Aid*** may offer immediate support to Service women.

Risk 3:

Women operating in GCC roles will have ***increased*** occurrences of infertility in primary care.

Mitigations:

No evidence-based mitigations available.

Further understanding of causes required.

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8 References

1. Ministry of Defence. Women in Ground Close Combat Review. London 2014. Source: GOV.UK.
2. Richmond VL, Carter JM, Wilkinson DM, Horner FE, Rayson MP, Wright A, et al. Comparison of the physical demands of single-sex training for male and female recruits in the British Army. Military Medicine. 2012;177(6):709-15.
3. Richmond V, Wilkinson D, Rayson M. Physical demands of the Commissioning Course for Officer Cadets at the Royal Military Academy Sandhurst. Report to Headquarters Army Recruiting and Training Directorate. 2010.
4. Wilkinson DM, Rayson MP, Bilzon JL. A physical demands analysis of the 24-week British Army Parachute Regiment recruit training syllabus. Ergonomics. 2008;51(5):649-62.
5. Defence Statistics (Health). Annual Medical Discharges in the UK Regular Armed Forces 2010/11-2014/15. Bristol: Defence Statistics, 2015.
6. Defence Statistics (Health). UK Armed Forces Mental Health: Annual Summary and Trends over Time 2007/8-2014/15. Bristol: National Office of Statistics, 2015.
7. Defence Statistics (Health). Women in Ground Close Combat Review. Defence Statistics (Health)/124/1/28. Bristol: Defence Statistics, 2016.
8. Defence Statistics (Health). Women in Combat Review: Mental Health Disorders in the UK Armed Forces by Gender: Update. Bristol: National Office of Statistics, 2015.
9. Office of National Statistics. Better or worse: a follow-up study of the mental health of adults in Great Britain. London 2003.
10. Oliver MI, Pearson N, Coe N, Gunnell D. Help-seeking behaviour in men and women with common mental health problems: cross-sectional study. The British Journal of Psychiatry. 2005;186(4):297-301.
11. Defence Statistics (Health). UK Armed Forces mental health: Annual Summary and Trends over Time, 2007/8-2013/14. Bristol: Defence Statistics, 2014.
12. Crum-Cianflone NF, Jacobson I. Gender differences of postdeployment post-traumatic stress disorder among service members and veterans of the Iraq and Afghanistan conflicts. Epidemiologic Reviews. 2014;36(1):5-18.
13. Riddle JR, Smith TC, Smith B, Corbeil TE, Engel CC, Wells TS, et al. Millennium Cohort: the 2001-2003 baseline prevalence of mental disorders in the US military. Journal of Clinical Epidemiology. 2007;60(2):192-201.
14. Woodhead C, Wessely S, Jones N, Fear N, Hatch S. Impact of exposure to combat during deployment to Iraq and Afghanistan on mental health by gender. Psychological Medicine. 2012;42(09):1985-96.
15. Richmond VL, Horner FE, Wilkinson DM, Rayson MP, Wright A, Izard R. Energy balance and physical demands during an 8-Week arduous military training course. Military Medicine. 2014;179(4):421-7.
16. Fortes M, Diment C, Greeves J, Casey A, Izard R, Walsh N. Effects of a daily mixed nutritional supplement on physical performance, body composition, and circulating anabolic hormones during 8 weeks of arduous military training. Applied Physiology, Nutrition and Metabolism. 2011;36(6):967-75.
17. Diment BC, Fortes MB, Greeves JP, Casey A, Costa RJ, Walters R, et al. Effect of daily mixed nutritional supplementation on immune indices in soldiers undertaking an 8-week arduous training programme. European Journal of Applied Physiology. 2012;112(4):1411-8.
18. Hill N, Woods D, Delves S, Murphy K, Davison A, Brett S, et al. The gonadotrophic response of Royal Marines during an operational deployment in Afghanistan. Andrology. 2015;3(2):293-7.

19. Otis CL, Drinkwater B, Johnson M, Loucks A, Wilmore J. American College of Sports Medicine position stand. The Female Athlete Triad. Medicine and Science in Sports and Exercise. 1997;29(5):i-ix.

20. Lauder TD. The female athlete triad: prevalence in military women. DTIC Document. Madigan Army Medical Center, 1997.

21. Nattiv A, Loucks A, Manore M, Sanborn C, Sundgot-Borgen J, Warren M. The female athlete triad special communications: position stand. Medicine and Science in Sports and Exercise. 2007;39(10):1867-82.

22. De Souza MJ, Lee DK, VanHeest JL, Scheid JL, West SL, Williams NI. Severity of energy-related menstrual disturbances increases in proportion to indices of energy conservation in exercising women. Fertility and Sterility. 2007;88(4):971-5.

23. Ackerman KE, Nazem T, Chapko D, Russell M, Mendes N, Taylor AP, et al. Bone microarchitecture is impaired in adolescent amenorrheic athletes compared with eumenorrheic athletes and nonathletic controls. The Journal of Clinical Endocrinology & Metabolism. 2011;96(10):3123-33.

24. Barrack MT, Gibbs JC, De Souza MJ, Williams NI, Nichols JF, Rauh MJ, et al. Higher incidence of bone stress injuries with increasing Female Athlete Triad-related risk factors a prospective multisite study of exercising girls and women. The American Journal of Ssports Medicine. 2014;42(4):949-58.

25. Loucks A, Verdun M, Heath E. Low energy availability, not stress of exercise, alters LH pulsatility in exercising women. Journal of Applied Physiology. 1998;84(1):37-46.

26. Nindl BC, Barnes BR, Alemany JA, Frykman PN, Shippee RL, Friedl KE. Physiological consequences of US Army Ranger training. Medicine and Science in Sports and Exercise. 2007;39(8):1380-7.

27. McNulty PAF. Prevalence and contributing factors of eating disorder behaviors in active duty service women in the Army, Navy, Air Force and Marines. Military medicine. 2001;166(1):53-58

28. Jacobson IG, Smith TC, Smith B, Keel PK, Amoroso PJ, Wells TS, et al. Disordered eating and weight changes after deployment: longitudinal assessment of a large US military cohort. American Journal of Epidemiology. 2009;169(4):415-27.

29. Dhalwani N, Fiaschi L, West J, Tata L. Occurrence of fertility problems presenting to primary care: population-level estimates of clinical burden and socioeconomic inequalities across the UK. Human Reproduction. 2013;28(4):960-8.

30. Townsend P, Phillimore P, Beattie A. Health and deprivation: inequality and the North: Routledge; 1988.

31. Constable S, Palmer B. The process of physical fitness standards development. DTIC Document. Human Systems Information Analysis Center, 2000.

32. Health and Safety at Work etc. Act 1974. Source: Legislation.gov.uk.

33. Equality Act 2010. London. Source: Legislation.gov.uk.

34. Payne W, Harvey J. A framework for the design and development of physical employment tests and standards. Ergonomics. 2010;53(7):858-71.

35. Tipton M, Milligan G, Reilly T. Physiological employment standards I. Occupational fitness standards: objectively subjective? European Journal of Applied Physiology. 2013;113(10):2435-46.

36. Rayson M, Pynn H, Rothwell A, Nevill A. The development of physical selection procedures for the British Army. Phase 3: Validation. Contemporary Ergonomics. 2000 Apr 6:140-4.

37. Nindl BC, Jones BH, Van Arsdale SJ, Kelly K, Kraemer WJ. Operational physical performance and fitness in military women: physiological, musculoskeletal injury, and optimized physical training considerations for successfully integrating women into combat-centric military occupations. Military Medicine. 2016;181(1S):50-62.

38. Harman E, Frykman P, Palmer C, Lammi E, Reynolds K. Effects of a Specifically Designed Physical Conditioning Program on the Load Carriage and Lifting Performance of Female Soldiers. DTIC Document. US Army Research Institute of Environmental Medicine, 1997.

39. Kraemer WJ, Mazzetti SA, Nindl BC, Gotshalk LA, Volek JS, Bush JA, et al. Effect of resistance training on women's strength/power and occupational performances. Medicine and Science in Sports and Exercise. 2001;33(6):1011-25.

40. Fleck SJ. Periodized strength training: a critical review. The Journal of Strength and Conditioning Research. 1999;13(1):82-9.

41. Roy TC, Knapik JJ, Ritland BM, Murphy N, Sharp MA. Risk factors for musculoskeletal injuries for soldiers deployed to Afghanistan. Aviation, Space and Environmental Medicine. 2012;83(11):1060-6.

42. Knapik JJ, Harman EA, Steelman RA, Graham BS. A systematic review of the effects of physical training on load carriage performance. The Journal of Strength and Conditioning Research. 2012;26(2):585-97.

43. Sharma J, Greeves JP, Byers M, Bennett AN, Spears IR. Musculoskeletal injuries in British Army recruits: a prospective study of diagnosis-specific incidence and rehabilitation times. BMC Musculoskeletal Disorders. 2015; 16:106.

44. Bullock SH, Jones BH, Gilchrist J, Marshall SW. Prevention of physical training-related injuries: recommendations for the military and other active populations based on expedited systematic reviews. American Journal of Preventive Medicine. 2010;38(1):S156-S81.

45. Knapik JJ, Hauret KG, Arnold S, Canham-Chervak M, Mansfield A, Hoedebecke E, et al. Injury and fitness outcomes during implementation of physical readiness training. DTIC Document. US Army Center for Health Promotion and Preventive Medicine, 2003.

46. Rudzki SJ. Injuries in Australian Army recruits. Part I: Decreased incidence and severity of injury seen with reduced running distance. Military Medicine. 1997;162(7):472-6.

47. Roos L, Boesch M, Sefidan S, Frey F, Mäder U, Annen H, et al. Adapted marching distances and physical training decrease recruits' injuries and attrition. Military Medicine. 2015;180(3):329-36.

48. Pope RP. Prevention of pelvic stress fractures in female army recruits. Military medicine. 1999;164(5):370-3.

49. Bedno SA, Cowan DN, Urban N, Niebuhr DW. Effect of pre-accession physical fitness on training injuries among US Army recruits. Work. 2013;44(4):509-15.

50. Cowan DN, Bedno SA, Urban N, Lee DS, Niebuhr DW. Step test performance and risk of stress fractures among female army trainees. American Journal of Preventive Medicine. 2012;42(6):620-4.

51. Blacker SD, Wilkinson DM, Rayson MP. Gender differences in the physical demands of British Army recruit training. Military Medicine. 2009;174(8):811-6.

52. Knapik JJ, Trone DW, Tchandja J, Jones BH. Injury-reduction effectiveness of prescribing running shoes on the basis of foot arch height: summary of military investigations. Journal of Orthopaedic & Sports Physical Therapy. 2014;44(10):805-12.

53. Mattila V, Sillanpää P, Salo T, Laine HJ, Mäenpää H, Pihlajamäki H. Can orthotic insoles prevent lower limb overuse injuries? A randomized-controlled trial of 228 subjects. Scandinavian Journal of Medicine & Science in Sports. 2011;21(6):804-8.

54. Mattila VM, Sillanpää P, Salo T, Laine H-J, Mäenpää H, Pihlajamäki H. Orthotic insoles do not prevent physical stress-induced low back pain. European Spine Journal. 2011;20(1):100-4.

55. Knapik JJ, Trone DW, Swedler DI, Villasenor A, Bullock SH, Schmied E, et al. Injury reduction effectiveness of assigning running shoes based on plantar shape in Marine Corps basic training. The American Journal of Sports Medicine. 2010;38(9):1759-67.

56. Franklyn-Miller A, Wilson C, Bilzon J, McCrory P. Foot orthoses in the prevention of injury in initial military training a randomized controlled trial. The American Journal of Sports Medicine. 2011;39(1):30-7.

57. Knapik JJ, Darakjy S, Swedler D, Amoroso P, Jones BH. Parachute ankle brace and extrinsic injury risk factors during parachuting. Aviation, Space, and Environmental Medicine. 2008;79(4):408-15.

58. Scott SJ, Feltwell DN, Knapik JJ, Barkley CB, Hauret KG, Bullock SH, et al. A multiple intervention strategy for reducing femoral neck stress injuries and other serious overuse injuries in US Army Basic Combat Training. Military Medicine. 2012;177(9):1081-9.

59. Greeves J. Final Report: Pregnancy, Postpartum and Physical Performance in Female Military Personnel. QinetiQ, 2006 Contract No.: QinetiQ/06/00080.

60. Cordell R, Wickes C, Greeves J, Messer P, Casey A. The morbidity of postpartum UK service women return to duty following maternity leave, proceedings of the International Congress on Soldiers Physical Performance; 2005; Finland.

61. Hopkinson JM, Butte NF, Ellis K, Smith EB. Lactation delays postpartum bone mineral accretion and temporarily alters its regional distribution in women. The Journal of Nutrition. 2000;130(4):777-83.

62. Exercise in Pregnancy. London: Royal College of Obstetrics and Gynaecology, 2006.

63. Jones N, Seddon R, Fear NT, McAllister P, Wessely S, Greenberg N. Leadership, cohesion, morale, and the mental health of UK Armed Forces in Afghanistan. Psychiatry. 2012;75(1):49-59.

64. Wilson S. Examination of the evidence for preparing, sustaining and enhancing psychological and physical well-being (psychological resilience). Porton Down: Defence Human Capability Science & Technology Centre, 2014.

9 List of Abbreviations

AFT ..... Annual Fitness Test

ALARP ..... As low as reasonably practicable

ARTD ..... Army Recruiting and Training Division

ATC(P) ..... Army Training Centre Pirbright

BFT ..... Basic Fitness Tests

CCOCB ..... Current Core Operating Capability Baseline

CFT ..... Combat Fitness Test

CI ..... Confidence Interval

CMS(GS) ..... Common Military Syllabus for Generic Soldier

CTCRM ..... Commando Training Centre Royal Marines

DS ..... Defence Statistics

DS(H) ..... Defence Statistics Health

DMICP ..... Defence Medical Information Capability Programme

EMIS PCS ..... Egerton Medical Information System Primary Care System

F ..... Female

GCC ..... Ground Close Combat

HCav ..... Household Cavalry

JMES ..... Joint Medical Employment Standards

JPA ..... Joint Personnel Administration

ITC(C) ..... Infantry Training Centre Catterick

MD ..... Medical Discharge

M ..... Male

MDS ..... Medical Deployment Standard

MFD ..... Medically Fully Deployable

MH ..... Mental Health

MHFA ..... Mental Health First Aid

MLD ..... Medically Limited Deployable

MND ..... Medically Not Deployable

MODREC ..... MOD Research Ethics Committee

MSkI ..... Musculoskeletal Injury

NS MBOS ..... Naval Service Medical Board of Survey

OCdts ..... Officer Cadets

PES ..... Physical Employment Standards

PES TWG ..... Physical Employment Standards Working Group

PT ..... Physical Training

RA ..... Royal Artillery

RAC ..... Royal Armoured Corps

RAFFT ..... RAF Fitness Test

RE ..... Royal Engineers

RR ..... Relative Risk

RLC ..... Royal Logistic Corps

RMAS ..... Royal Military Academy Sandhurst

RM ..... Royal Marines

SE ..... Standard Entrants

WGCC ..... Women in Ground Close Combat

A APPENDIX A: Tables of Results

Table A 1. Rate (per 1000 trainees) and relative risk (RR (95% CI)) of reported training injuries between male (M) and female (F) Standard Entrants, Officer Cadets and Infantry trainees[11].

Number of reported injuries and numbers into training between September 2011 and December 2015.

Trainees	Number of reported injuries		Numbers into training		Rate of injury		RR
	M	F	M	F	M	F	
TRAUMA							
Standard Entrants	956	304	11,218	2,227	85.22	136.51	**1.60**** (1.42,1.81)
Officer Cadets	920	153	2,456	393	374.59	389.31	1.04 (0.91,1.19)
Infantry	1,440	…	12,336	…	116.73	…	…
OVERUSE							
Standard Entrants	1,298	490	11,218	2,227	115.71	220.03	**1.90**** (1.73,2.09)
Officer Cadets	1,915	437	2,456	393	779.72	1,111.96	-
Infantry	4,259	…	12,336	…	345.25	…	…
STRESS FRACTURE							
Standard Entrants	83	53	11,218	2,227	7.40	23.80	**3.22**** (2.29,4.63)
Officer Cadets	10	7	2,456	393	4.07	17.81	**4.38**†** (1.68,11.43)
Infantry	650	…	12,336	…	52.69	…	…
HIP/PELVIS STRESS FRACTURE							
Standard Entrants	16	33	11,218	2,227	1.43	14.82	**10.39**** (5.73,18.85)
Officer Cadets	~	~	2,456	393	~	~	**18.75**** (1.95,179.90)
Infantry	133	…	12,336	…	10.78	…	…

11 **P<0.001 (Chi-square). RR, 95% CI and statistical significance could not be determined for Officer Cadets overuse injuries as the number of injuries exceeded the number of individuals into training. Ellipses denote no available data, ~ data suppressed as <5 cases, † fewer than 10 cases so statistical significance should be treated with caution.

Table A 2. Rate (per 1000 trainees) of reported overuse lower limb musculoskeletal injuries in male (M) and female (F) Standard Entrants, Officer Cadets and Infantry trainees by anatomical site[12].

Number of reported injuries and numbers into training between September 2011 and December 2015.

Trainees	Number of reported injuries		Numbers into training		Rate of injury		RR
	M	F	M	F	M	F	
HIP							
Standard Entrants	62	71	11,218	2,227	5.53	31.88	**5.77**** (4.12,8.09)
Officer Cadets	142	67	2,456	393	57.82	170.48	**2.95**** (2.25,3.86)
Infantry	366	…	12,336	…	29.67	…	…
THIGH							
Standard Entrants	14	14	11,218	2,227	1.25	6.29	**5.04**** (2.40,10.55)
Officer Cadets	117	17	2,456	393	47.64	43.26	0.91 (0.55,1.49)
Infantry	141	…	12,336	…	11.43	…	…
KNEE							
Standard Entrants	350	94	11,218	2,227	31.20	42.21	**1.35*** (1.08,1.69)
Officer Cadets	361	47	2,456	393	146.99	119.59	0.81 (0.61,1.08)
Infantry	1,013	…	12,336	…	82.12	…	…
CALF/SHIN							
Standard Entrants	160	53	11,218	2,227	14.26	23.80	**1.67*** (1.23,2.31)
Officer Cadets	343	82	2,456	393	139.66	208.65	**1.49**** (1.20,1.86)
Infantry	532	…	12,336	…	43.13	…	…
ANKLE							
Standard Entrants	71	27	11,218	2,227	6.33	12.12	**1.92**** (1.23,2.98)
Officer Cadets	84	18	2,456	393	34.20	45.80	1.34 (0.81,2.20)
Infantry	325	…	12,336	…	26.35	…	…
FOOT							
Standard Entrants	161	68	11,218	2,227	14.35	30.53	**2.13**** (1.61,2.82)
Officer Cadets	192	52	2,456	393	78.18	132.32	**1.69**** (1.27,2.26)
Infantry	434	…	12,336	…	35.18	…	…

12 *P<0.01, **P<0.001 (Chi-square). Ellipses denote no available data.

Table A 3. Rates (per 1000 trainees) and relative risk (RR (95% CI)) of reported training injuries between male Standard Entrants (ATC(P)) and male Infantry trainees (ITC(C))[13] .

Number of reported injuries and numbers into training between September 2011 and December 2015.

Trainees	Number of reported injuries		Numbers into training		Rate of MD		RR
	ATC (P)	ITC (C)	ATC (P)	ITC (C)	ATC (P)	ITC (C)	
Trauma	956	1,440	11,218	12,336	85.22	116.73	**1.37**** (1.27,1.48)
Overuse	1,298	4,259	11,218	12,336	115.71	345.25	**2.98**** (2.82,3.16)
Stress Fracture	83	650	11,218	12,336	7.40	52.69	**7.12**** (5.68,8.94)
Hip/Pelvis Stress Fracture	16	133	11,218	12,336	1.43	10.78	**7.56**** (4.50,12.69)

Table A 4. Rate (per 1000 trainees) and relative risk (RR (95% CI)) of musculoskeletal injuries by anatomical site in RAF trainees[14].

MSkI: Number of reported injuries and numbers into training between April 2014 and March 2016.

Pelvic Stress Injury: Number of reported injuries and numbers into training between April 2009 and March 2016.

RAF trainees	Number of reported injuries		Numbers into training		Rate of injury		RR
	M	F	M	F	M	F	
MUSCULOSKELETAL INJURY (MSkI) DATA							
All MSkI	89	50	2,652	508	33.56	98.43	**2.93**** (2.10,4.09)
Upper limb	17	5	2,652	508	6.41	9.84	1.54† (0.57,4.14)
Hip	8	22	2,652	508	3.02	43.31	**14.36**** (6.43,32.07)
Lower limb (trauma)	10	5	2,652	508	3.77	9.84	2.61† (0.90,7.61)
Lower limb (overuse)	57	37	2,652	508	21.49	72.83	**3.39**** (2.27,5.07)
PELVIC STRESS INJURY DATA							
Pelvic stress injuries	5	48	7,437	1,475	0.67	32.54	**48.40****† (19.30,121.40)

13 **P<0.001 (Chi-square).

14 **P<0.001, † fewer than 10 cases so statistical significance should be treated with caution.

Table A 5. Rates (per 1000 trainees) and relative risk (RR (95% CI)) of medical discharge between male (M) and female (F) Standard Entrants, Officer Cadets and Infantry trainees by anatomical site[15].

Number of trainees MD and numbers into training between April 2012 and December 2015.

Trainees	Number of trainees MD		Numbers into training		Rate of injury		RR
	M	F	M	F	M	F	
ALL MSkI							
Standard Entrants	152	50	9,875	1,713	15.39	29.19	**1.90**** (1.38,2.60)
Officer Cadets	45	32	1,986	309	22.66	103.56	**4.57**** (2.95,7.08)
Infantry	801	…	9,245	…	86.64	…	…
UPPER LIMB							
Standard Entrants	11	~	9,875	1,713	1.11	~	0.52† (0.07,4.06)
Officer Cadets	5	~	1,986	309	2.52	~	1.29† (0.15,10.97)
Infantry	47	…	9,245	…	5.08	…	…
HIP							
Standard Entrants	5	8	9,875	1,713	0.51	4.67	**9.22**** (3.02,28.17)
Officer Cadets	~	6	1,986	309	~	19.42	**12.85**†** (3.23,51.15)
Infantry	76	…	9,245	…	8.22	…	…
LOWER LIMB							
Standard Entrants	100	38	9,875	1,713	10.13	22.18	**2.19**** (1.51,3.17)
Officer Cadets	27	18	1,986	309	13.60	58.25	**4.29**** (2.39,7.69)
Infantry	522	…	9,245	…	56.46	…	…

DATA SOURCE: ARTD medical discharge register

15 **P<0.001 (Chi-square). Ellipses denote no available data, ~ data suppressed as <5 cases, † fewer than 10 cases so statistical significance should be treated with caution. MD from a training-related injury with a 9.385 or P8 discharge code.

Table A 6. Rates (per 1000 trainees) and relative risk (RR (95% CI)) of medical discharge between male Standard Entrants (ATC(P)) and male Infantry trainees (ITC(C)) by anatomical site[16].

Number of trainees MD and numbers into training between April 2012 and December 2015.

	Number of trainees MD		Numbers into training		Rate of MD		RR
	ATC(P)	ITC(C)	ATC(P)	ITC(C)	ATC(P)	ITC(C)	
All MSkI	152	801	9,875	9,245	15.39	86.64	**5.63**** (4.74,6.68)
Upper Limb	11	47	9,875	9,245	1.11	5.08	**4.57**** (2.37,8.81)
Hip	5	76	9,875	9,245	0.51	8.22	**16.24**†** (6.57,40.12)
Lower Limb	100	522	9,875	9,245	10.13	56.46	**5.58**** (4.51,6.89)

DATA SOURCE: ARTD medical discharge register

Table A 7. Rate (per 1000 Service personnel) and relative risk (RR (95% CI)) of medical discharge between men (M) and women (F) by Service[17].

Service personnel MD and Service personnel in trained strength over financial years 2010/2011 to 2014/2015

Service	Service personnel MD (n)		Service personnel (n)		Rate of MD		RR
	M	F	M	F	M	F	
Royal Navy	1,624	263	31,533	3,483	51.50	75.51	**1.47**** (1.29,1.67)
Army	7,147	678	94,662	8,268	75.50	82.00	1.09 (1.01,1.17)
Royal Air Force	667	187	33,350	5,123	20.00	36.50	**1.83**** (1.56,2.14)

DATA SOURCE: JPA; Defence Statistics

16 **P<0.001 (Chi-square). † fewer than 10 cases so statistical significance should be treated with caution. MD from a training-related injury with a 9.385 or P8 discharge code.

17 **P<0.001 (Chi-square).

Table A 8. Rate (per 1000 personnel) and relative risk (RR (95% CI)) of medical downgrading in Service men and women[18].

Service personnel downgraded and Service personnel in trained strength as at 01 November 2015.

Corps	Service personnel downgraded (n)		Service personnel (n)		Rate of medical downgrade		RR
	M	F	M	F	M	F	
ALL-CAUSE							
RLC	2,281	526	9,411	1,363	242.38	385.91	**1.59**** (1.48,1.72)
RE	1,559	32	7,406	158	210.50	202.53	0.96 (0.70,1.31)
RA	1,341	137	5,568	485	240.84	282.47	**1.17*** (1.01,1.36)
MUSCULOSKELETAL DISORDERS							
RLC	1,223	194	9,411	1,363	129.95	142.33	1.10 (0.95,1.26)
RE	918	13	7,406	158	123.95	82.28	0.66 (0.39,1.12)
RA	755	66	5,568	485	135.60	136.08	1.00 (0.79,1.27)
MENTAL AND BEHAVIOURAL DISORDERS							
RLC	130	41	9,411	1,363	13.81	30.08	**2.18**** (1.54,3.08)
RE	89	0	7,406	158	12.02	0.00	0.00 -
RA	79	16	5,568	485	14.19	32.99	**2.33**** (1.37,3.95)

DATA SOURCE: DMICP; DS(H)

18 *P<0.01, **P<0.001 (Chi-square).

Table A 9. Rate (per 1000 personnel) and relative risk (RR (95% CI)) of all-cause medical downgrading by Corps in Service men and women[19].

Service personnel downgraded and Service personnel in trained strength as at 01 November 2015.

	Inf	HCav & RAC	RM	RAF Regt	RA	RE	RLC
MEN							
Medical downgrades (n)	3,811	849	865	210	1,341	1,559	2,281
Service personnel (n)	19,660	4,541	6,580	2,038	5,568	7,406	9,411
Rate of downgrade	193.85	186.96	131.46	103.04	240.84	210.50	242.38
RR	**0.80**** (0.76,0.84)	**0.77**** (0.72,0.83)	**0.54**** (0.50,0.58)	**0.43**** (0.16,0.23)	0.99 (0.94,1.05)	**0.87**** (0.82,0.92)	1.00 -
WOMEN							
Medical downgrades (n)	…	…	…	…	137	32	526
Service personnel (n)	…	…	…	…	485	158	1,363
Rate of downgrade	…	…	…	…	282.47	202.53	385.91
RR					**0.73**** (0.63,0.86)	**0.52**** (0.38,0.72)	1.00 -

DATA SOURCE: DMICP; DS(H)

19 **P<0.001 (Chi-square). Ellipses denote no available data. Inf, Infantry; HCav, Household Cavalry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps.

Table A 10. Rate (per 1000 personnel) and relative risk (RR (95% CI)) of medical downgrading due to musculoskeletal disorders by Corps in Service men and women[20].

Service personnel downgraded and Service personnel in trained strength as at 01 November 2015.

	Inf	HCav & RAC	RM	RAF Regt	RA	RE	RLC
MEN							
Medical downgrades (n)	1,725	438	450	95	755	918	1,223
Service personnel (n)	19,660	4,541	6,580	2,038	5,568	7,406	9,411
Rate of downgrade	87.74	96.45	68.39	46.61	135.60	123.95	129.95
RR	**0.68**** (0.63,0.72)	**0.74**** (0.69,0.82)	**0.53**** (0.47,0.58)	**0.36**** (0.29,0.44)	1.04 (0.96,1.14)	0.95 (0.88,1.03)	1.00 -
WOMEN							
Medical downgrades (n)	…	…	…	…	66	13	194
Service personnel (n)	…	…	…	…	485	158	1363
Rate of downgrade	…	…	…	…	136.08	82.28	142.33
RR	…	…	…	…	0.96 (0.74,1.24)	**0.58**** (0.34,0.99)	1.00 -

DATA SOURCE: DMICP; DS(H)

20 **P<0.001 (Chi-square). Ellipses denote no available data. Inf, Infantry; HCav, Household Cavalry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps.

Table A 11. Rate (per 1000 personnel) and relative risk (RR (95% CI)) of medical downgrading and 12 month injury incidence by Corps in Service men[21].

Personnel surveyed February-March 2016; current medical downgrades at the same time period.

Corps	Inf	RAC	RM	RAF Regt	RA	RE	RLC
CURRENT MEDICAL DOWNGRADE FOR MSkI							
Current downgrade (n)	18	13	14	18	28	42	33
Surveyed personnel (n)	148	93	123	135	126	138	157
Rate of downgrading	121.62	139.78	113.82	133.33	222.22	304.35	210.19
RR	0.58 (0.34,0.98)	0.67 (0.37,1.20)	0.54 (0.04,0.97)	0.63 (0.37,1.07)	1.06 (0.68,1.65)	1.45 (0.98,2.15)	1.00 -
12 MONTH MSkI INCIDENCE							
12 month injury incidence (n)	33	24	31	22	23	52	48
Surveyed personnel (n)	148	93	123	135	126	138	157
Rate of downgrading	222.97	258.06	252.03	162.96	182.54	376.81	305.73
RR	0.73 (0.50,1.07)	0.84 (0.55,1.28)	0.82 (0.56,1.21)	**0.53*** (0.34,0.84)	0.60 (0.39,0.93)	1.23 (0.89,1.70)	1.00 -

DATA SOURCE: Musculoskeletal injury questionnaire (trained Service personnel)

21 *P<0.01 (Chi-square). Inf, Infantry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps.

Table A 12. Absolute numbers, rate (per 1000 Service personnel) and relative risk (RR (95% CI)) of men and women leaving and transferring from the Service, and those MFD, (at 4 years) by role[22].

Total intake of Service personnel joining the trained strength, total Service personnel leaving or transferring from the Service at the 4 year point and total Service personnel remaining in Service, and MFD, at the 4 year point, all between 01 April 2011 and 31 December 2015.

Corps	Service personnel leaving (n)		Service personnel in Corps (n)		Rate of outflow		RR
	M	F	M	F	M	F	
OUTFLOW FROM SERVICE[23]							
RLC	2,652	414	5,955	978	445.34	423.31	0.95 (0.88,1.03)
RE	1,882	30	5,409	79	347.94	379.75	1.09 (0.82,1.45)
RA	1,583	162	3,968	367	398.94	441.42	1.11 (0.98,1.25)
TRANSFER FROM CORPS[24]							
RLC	300	63	5,955	978	50.38	64.42	1.28 (0.98,1.66)
RE	173	7	5,409	79	31.98	88.61	**2.77*†** (1.35,5.71)
RA	233	31	3,968	367	58.72	84.47	1.44 (1.00,2.06)

Corps	Service personnel MFD (n)		Service personnel remaining (n)		Rate of MFD		RR
	M	F	M	F	M	F	
PERCENTAGE MFD OF PERSONNEL REMAINING							
RLC	2,429	308	3,003	501	808.86	614.77	**0.76**** (0.71,0.82)
RE	2,765	30	3,354	42	824.39	714.29	0.87 (0.72,1.05)
RA	1,742	115	2,152	174	809.48	660.92	**0.82**** (0.73,0.91)

DATA SOURCE: DMICP; DS(H)

22 **P<0.001 (Chi-square). † fewer than 10 cases so statistical significance should be treated with caution. RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps.

23 Only includes personnel who joined the trained strength in the Corps of interest and were no longer in the same role at the 4 year Service point (they may transfer roles in between).

24 Personnel who transferred to another Corps or Service but remained within the UK Armed Forces

Table A 13. Absolute numbers, rate (per 1000 Service personnel) and relative risk (RR (95% CI)) of men and women leaving the Service (at 4 years) by role[25].

Total intake of Service personnel joining the trained strength between 01 April 2007 and 31 December 2011. Total Service personnel leaving Service at the 4 year point between 01 April 2011 and 31 December 2015.

	Inf	HCav & RAC	RM	RAF Regt	RA	RE	RLC
MEN							
Personnel leaving Service (n)	10,198	1,386	1,868	673	1,583	1,882	2,652
Total intake of Service personnel (n)	20,350	3,305	4,803	1,501	3,968	5,409	5,955
Rate of outflow (per 1000 Service personnel)	501.13	419.36	388.92	448.37	398.94	347.94	445.34
RR	**1.13**** (1.09,1.16)	**0.94*** (0.90,0.99)	**0.87**** (0.83,0.91)	1.01 (0.95,1.07)	**0.90**** (0.85,0.94)	**0.78**** (0.75,0.82)	1.00 -
WOMEN							
Personnel leaving Service (n)	…	…	…	…	162	30	414
Total intake of Service personnel (n)	…	…	…	…	367	79	978
Rate of outflow (per 1000 Service personnel)	…	…	…	…	441.42	379.75	423.31
RR	…	…	…	…	1.04 (0.91,1.20)	0.90 (0.67,1.20)	1.00 -

DATA SOURCE: Defence Statistics Loose Minute; 24 March 2016

25 **P<0.001 (Chi-square). Inf, Infantry; HCav, Household Cavalry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps. Ellipses denote no available data. Data only includes personnel who joined the trained strength in the Corps of interest and were no longer in the same role at the 4 year Service point (they may transfer roles in between).

Table A 14. Absolute numbers, rate (per 1000 Service personnel) and relative risk (RR (95% CI)) of men and women transferring from the Corps (at 4 years) by role[26].

Total intake of Service personnel joining the trained strength between 01 April 2007 and 31 December 2011. Total transfer of Service personnel at the 4 year point between 01 April 2011 and 31 December 2015.

	Inf	HCav & RAC	RM	RAF Regt	RA	RE	RLC
MEN							
Service personnel transferred (n)	945	266	218	73	233	173	300
Total intake of Service personnel (n)	20,350	3,305	4,803	1,501	3,968	5,409	5,955
Rate of outflow (per 1000 Service personnel)	46.44	80.48	45.39	48.63	58.72	31.98	50.38
RR	0.92 (0.81,1.05)	**1.60**** (1.36,1.87)	0.90 (0.76,1.07)	0.97 (0.75,1.24)	1.17 (0.99,1.38)	**0.63**** (0.53,0.76)	1.00 -
WOMEN							
Service personnel transferred (n)	…	…	…	…	31	7	63
Total intake of Service personnel (n)	…	…	…	…	367	79	978
Rate of outflow (per 1000 Service personnel)	…	…	…	…	84.47	88.61	64.42
RR	…	…	…	…	1.31 (0.87,1.98)	1.38 (0.65,2.90)	1.00 -

DATA SOURCE: Defence Statistics Loose Minute; 24 March 2016

26 **P<0.001 (Chi-square). Inf, Infantry; HCav, Household Cavalry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps. Ellipses denote no available data. Data includes personnel who transferred to another Corps or Service but remained within the UK Armed Forces.

Table A 15. Rate (per 1000 Service personnel) and relative risk (RR (95% CI)) of men and women MFD (at 4 years) by role[27].

Total Service personnel remaining in Service, and MFD, at the 4 year point between 01 April 2011 and 31 December 2015.

	Inf	HCav & RAC	RM	RAF Regt	RA	RE	RLC
MEN							
Service personnel MFD (n)	7,416	1,358	2,412	669	1,742	2,765	2,429
Service personnel remaining in Service (n)	9,207	1,653	2,717	755	2,152	3,354	3,003
Rate of transfer (per 1000 Service personnel)	805.47	821.54	887.74	886.09	809.48	824.39	808.86
RR	1.00 (0.98,1.02)	1.02 (0.99,1.05)	**1.10**** (1.07,1.12)	**1.10**** (1.06,1.13)	1.00 (0.97,1.03)	1.02 (1.00,1.04)	1.00 -
WOMEN							
Service personnel MFD (n)	…	…	…	…	115	30	308
Service personnel remaining in Service (n)	…	…	…	…	174	42	501
Rate of transfer (per 1000 Service personnel)	…	…	…	…	660.92	714.29	614.77
RR	…	…	…	…	1.08 (0.95,1.22)	1.16 (0.95,1.42)	1.00 -

DATA SOURCE: Defence Statistics Loose Minute; 24 March 2016

27 **P<0.001 (Chi-square). Inf, Infantry; HCav, Household Cavalry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps. Ellipses denote no available data.

Table A 16. Rate (per 1000 personnel) and relative risk (RR (95% CI)) of medical downgrading by length of Service in Service men[28].

Service personnel downgraded and Service personnel in trained strength as at 01 November 2015.

Length of Service (years)	0-4	5-9	10-14	15-19	20-24	25-29	30+
INFANTRY							
Medical downgrades (n)	1,338	1,133	551	447	235	72	35
Service personnel (n)	8,038	5,458	2,881	1,941	934	299	109
Rate of downgrading	166.46	207.59	191.25	230.29	251.61	240.80	321.10
RR	1.00 -	**1.25**** (1.16,1.34)	**1.15*** (1.05,1.26)	**1.38**** (1.26,1.52)	**1.51**** (1.34,1.71)	**1.45**** (1.18,1.78)	**1.93**** (1.46,2.55)
HOUSEHOLD CAVALRY/ROYAL ARMOURED CORPS							
Medical downgrades (n)	194	274	151	133	48	43	6
Service personnel (n)	1,595	1,376	718	517	188	125	22
Rate of downgrading	121.63	199.13	210.31	257.25	255.32	344.00	272.73
RR	1.00 -	**1.64**** (1.38,1.94)	**1.73**** (1.43,2.10)	**2.12**** (1.74,2.58)	**2.10**** (1.59,2.77)	**2.83**** (2.15,3.73)	2.24 (1.12,4.49)
ROYAL MARINES							
Medical downgrades (n)	189	263	132	119	60	72	30
Service personnel (n)	2,118	2,072	1,049	637	338	263	103
Rate of downgrading	89.24	126.93	125.83	186.81	177.51	273.76	291.26
RR	1.00 -	**1.42**** (1.19,1.70)	**1.41*** (1.40,1.74)	**2.09**** (1.69,2.59)	**1.99**** (1.52,2.60)	**3.07**** (2.42,5.24)	**3.26**** (2.35,6.58)
RAF REGIMENT							
Medical downgrades (n)	35	74	33	28	6	19	15
Service personnel (n)	488	640	339	299	64	116	92
Rate of downgrading	71.72	115.63	97.35	93.65	93.75	163.79	163.04
RR	1.00 -	1.61 (1.10,2.37)	1.36 (0.86,2.14)	1.31 (0.81,2.10)	1.31 (0.57,2.99)	**2.28*** (1.36,3.84)	**2.27*** (1.30,3.99)

Continued overleaf...

Length of Service (years)	0-4	5-9	10-14	15-19	20-24	25-29	30+
ROYAL ARTILLERY							
Medical downgrades (n)	266	461	253	216	~	~	13
Service personnel (n)	1,624	1,808	970	706	…	…	50
Rate of downgrading	163.79	254.98	260.82	305.95	…	…	260.00
RR	1.00 -	**1.56**** (1.36,1.78)	**1.59**** (1.37,1.86)	**1.87**** (1.60,2.18)	~	~	1.59 (0.98,2.57)
ROYAL ENGINEERS							
Medical downgrades (n)	~	469	256	~	178	73	18
Service personnel (n)	…	2,259	1,367	…	508	205	61
Rate of downgrading	…	207.61	187.27	…	350.39	356.10	295.08
RR	1.00 -	…	…	~	…	…	…
ROYAL LOGISTICS CORPS							
Medical downgrades (n)	366	543	592	413	~	~	17
Service personnel (n)	2,362	2,512	2,160	1,361	…	…	54
Rate of downgrading	154.95	216.16	274.07	303.45	…	…	314.81
RR	1.00 -	**1.40**** (1.24,1.57)	**1.77**** (1.57,1.99)	**1.96**** (1.73,2.22)	~	~	**2.03*** (1.36,3.05)

DATA SOURCE: DMICP; DS(H)

28 **P<0.001 (Chi-square). Inf, Infantry; HCav, Household Cavalry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps. Ellipses denote no available data ~ denotes data suppressed as <5 cases, RR not calculated because of suppressed data.

Table A 17. Rate (per 1000 personnel) and relative risk (RR (95% CI)) of medical downgrading by length of Service and Corps in Service women[30].

Service personnel downgraded and Service personnel in trained strength as at 01 November 2015

Length of Service (years)	0-4	5-9	10-14	15-19	20-24	25-29	30+
ROYAL ARTILLERY							
Medical downgrades (n)	43	49	20	22	~	~	…
Service personnel (n)	236	134	63	46	…	…	…
Rate of downgrading	182.20	365.67	317.46	478.26	…	…	…
RR	1.00 -	**2.01**** (1.41,2.85	1.74 (1.10,2.74)	**2.63**** (1.75,3.94)	~	~	…
ROYAL ENGINEERS							
Medical downgrades (n)	~	11	11		…	…	…
Service personnel (n)	…	72	32	…	…	…	…
Rate of downgrading	…	152.78	343.75	…	…	…	…
RR	1.00 -	…	…	…	…	…	…
ROYAL LOGISTICS CORPS							
Medical downgrades (n)	141	141	112	88	~	~	…
Service personnel (n)	473	368	245	185	…	…	…
Rate of downgrading	298.10	383.15	457.14	475.68	…	…	…
RR	1.00 -	**1.29*** (1.06,1.95)	**1.53**** (1.26,1.86)	**1.60**** (1.30,1.96)	~	~	…

DATA SOURCE: DMICP; DS(H)

29 **P<0.001 (Chi-square). Inf, Infantry; HCav, Household Cavalry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps. Ellipses denote no available data. ~ denotes data suppressed as <5 cases, RR not calculated because of suppressed data.

Table A 18. Rate (per 1000 personnel) and relative risk (RR (95% CI)) of medical downgrading due to mental and behavioural disorders by Corps in Service men and women[30].

Service personnel downgraded and Service personnel in trained strength as at 01 November 2015.

	Inf	HCav & RAC	RM	RAF Regt	RA	RE	RLC
MEN							
Medical downgrades (n)	290	50	36	21	79	89	130
Service personnel (n)	19,660	4,541	6,580	2,038	5,568	7,406	9,411
Rate of downgrade	14.75	11.01	5.47	10.30	14.19	12.02	13.81
RR	1.07 (0.87,1.31)	0.80 (0.58,1.10)	**0.40**** (0.27,0.57)	0.75 (0.47,1.18)	1.03 (0.78,1.36)	0.87 (0.67,1.14)	1.00 -
WOMEN							
Medical downgrades (n)	…	…	…	…	16	0	41
Service personnel (n)	…	…	…	…	485	158	1,363
Rate of downgrade	…	…	…	…	32.99	0.00	30.08
RR	…	…	…	…	1.10 (0.62,1.94)	0.00 -	1.00 -

DATA SOURCE: DMICP; DS(H)

30 **P<0.001 (Chi-square). Ellipses denote no available data. Inf, Infantry; HCav, Household Cavalry; RAC, Royal Armoured Corps; RM, Royal Marines; RAF Regt, RAF Regiment; RA, Royal Artillery; RE, Royal Engineers; RLC, Royal Logistic Corps.

Table A 19. Rate (per 1000 person years) of reported fertility problems in Service women compared with the civilian population[31].

Occurrence of fertility problems and Service personnel in the trained strength between January 2013 and December 2015

Age (years)	Occurrence of fertility problems (n)	Service personnel (n)	Rate of occurrence of fertility problems
15-19	~	~	1.23
20-24	31	7,683	4.03
25-29	67	11,577	5.79
30-34	163	10,744	15.17
35-39	155	6,939	22.34
40-44	46	4,119	11.17
45-49	6	1,486	4.04

DATA SOURCE: DMICP

31 Data captured for calendar years 2013 to 2015. Occurrences of fertility problems were only counted on the first occasion they were coded for during the reporting period. ~ data suppressed as <5 cases.

B | APPENDIX B: Medical downgrade by cause in the trained strength (DS(H))

Trained UK Regular Armed Forces personnel currently medically downgraded[1] by role[2], sex and principal cause of downgrading category as at 1 November 2015. Numbers and percentage of personnel at risk[3 4 5]

	Army								Royal Marines		RAF	
	HCav/RAC				Infantry				GCC		GCC	
GCC	Male		Female		Male		Female		Males only		Males only	
	n	%	n	%	n	%	n	%	n	%	n	%
All personnel downgraded	849	18.7%	0		3,811	19.4%	0		865	13.1%	210	10.3%
All principle causes for downgrading	857	100.0%	0	-	3,853	100.0%	0	-	865	100.0%	268	100.0%
Infectious and parasitic diseases (A00 - B99)	~	~	0	-	10	0.3%	0	-	~	~	~	~
Neoplasms (C00 - D48)	6	0.7%	0	-	17	0.4%	0	-	9	1.0%	~	~
Blood disorders (D50 - D89)	~	~	0	-	8	0.2%	0	-	~	~	~	~
Endocrine, nutritional and metabolic diseases (E00 - E90)	7	0.8%	0	-	33	0.9%	0	-	~	~	~	~
Mental and behavioural disorders (F00 - F99)	50	5.8%	0	-	290	7.5%	0	-	36	4.2%	21	7.8%
Nervous system disorders (G00 - G99)	9	1.1%	0	-	30	0.8%	0	-	8	0.9%	~	~
Eye and adnexa diseases (H00 - H59)	8	0.9%	0	-	5	0.1%	0	-	0	-	0	-
Ear and mastoid process diseases (H60 - H95)	39	4.6%	0	-	281	7.3%	0	-	38	4.4%	6	2.2%
Circulatory system disorders (I00 - I99)	16	1.9%	0	-	39	1.0%	0	-	18	2.1%	6	2.2%
Respiratory system disorders (J00 - J99)	17	2.0%	0	-	49	1.3%	0	-	12	1.4%	~	~
Digestive system disorders (K00 - K93)	13	1.5%	0	-	56	1.5%	0	-	20	2.3%	~	~
Skin and subcutaneous tissue diseases (L00 - L99)	5	0.6%	0	-	27	0.7%	0	-	6	0.7%	~	~
Musculoskeletal disorders (M00 - M99) and Injuries (S00 - T98)	438	51.1%	0	-	1,725	44.8%	0	-	450	52.0%	95	35.4%
Genitourinary system diseases (N00 - N99)	~	~	0	-	25	0.6%	0	-	~	~	0	-
Pregnancy, childbirth and the puerperium (O00 - O99)	0	-	0	-	0	-	0	-	0	-	0	-
Clinical and laboratory findings (R00 - R99)	21	2.5%	0	-	78	2.0%	0	-	21	2.4%	7	2.6%
Congenital malformations (Q00 - Q99)	~	~	0	-	9	0.2%	0	-	~	~	0	-
External causes of morbidity and mortality (V01-Y98)	0	-	0	-	0	-	0	-	~	~	0	-
Factors influencing health status (Z00 - Z99)	~	~	0	-	43	1.1%	0	-	21	2.4%	~	~
Read code not mapped to ICD-105	**9**	**1.1%**	**0**	**-**	**27**	**0.7%**	**0**	**-**	**14**	**1.6%**	**1**	**0.4%**
No cause information entered[5]	**210**	**24.5%**	**0**	**-**	**1,101**	**28.6%**	**0**	**-**	**199**	**23.0%**	**114**	**42.5%**

	Army											
	RA				RE				RLC			
NGCC	Male		Female		Male		Female		Male		Female	
	n	%	n	%	n	%	n	%	n	%	n	%
All personnel downgraded	1,341	24.1%	137	28.2%	1,559	21.1%	32	20.3%	2,281	24.2%	526	38.6%
All principle causes for downgrading	1,362	100.0%	139	100.0%	1,590	100.0%	33	100.0%	2,365	100.0%	541	100.0%
Infectious and parasitic diseases (A00 - B99)	~	~	0	-	5	0.3%	0	-	~	~	~	~
Neoplasms (C00 - D48)	6	0.4%	0	-	12	0.8%	0	-	15	0.6%	~	~
Blood disorders (D50 - D89)	~	~	0	-	~	~	0	-	6	0.3%	~	~
Endocrine, nutritional and metabolic diseases (E00 - E90)	~	~	0	-	16	1.0%	0	-	31	1.3%	8	1.5%
Mental and behavioural disorders (F00 - F99)	79	5.8%	16	11.5%	89	5.6%	~	~	130	5.5%	41	7.6%
Nervous system disorders (G00 - G99)	15	1.1%	~	~	13	0.8%	0	-	17	0.7%	6	1.1%
Eye and adnexa diseases (H00 - H59)	~	~	~	~	~	~	~	~	5	0.2%	~	~
Ear and mastoid process diseases (H60 - H95)	51	3.7%	0	-	49	3.1%	0	-	71	3.0%	~	~
Circulatory system disorders (I00 - I99)	18	1.3%	~	~	29	1.8%	0	-	56	2.4%	~	~
Respiratory system disorders (J00 - J99)	24	1.8%	~	~	36	2.3%	0	-	47	2.0%	17	3.1%
Digestive system disorders (K00 - K93)	20	1.5%	~	~	25	1.6%	~	~	49	2.1%	~	~
Skin and subcutaneous tissue diseases (L00 - L99)	11	0.8%	0	-	10	0.6%	0	-	17	0.7%	~	~
Musculoskeletal disorders (M00 - M99) and Injuries (S00 - T98)	755	55.4%	66	47.5%	918	57.7%	13	39.4%	1,223	51.7%	194	35.9%
Genitourinary system diseases (N00 - N99)	10	0.7%	~	~	~	~	0	-	9	0.4%	~	~
Pregnancy, childbirth and the puerperium (O00 - O99)	0	-	0	-	0	-	0	-	0	-	0	-
Clinical and laboratory findings (R00 - R99)	18	1.3%	~	~	32	2.0%	0	-	43	1.8%	14	2.6%
Congenital malformations (Q00 - Q99)	~	~	0	-	0	-	0	-	~	~	~	~
External causes of morbidity and mortality (V01-Y98)	~	~	0	-	0	-	0	-	0	-	0	-
Factors influencing health status (Z00 - Z99)	6	0.4%	17	12.2%	13	0.8%	7	21.2%	19	0.8%	96	17.7%
Read code not mapped to ICD-105	**8**	**0.6%**	**1**	**0.7%**	**21**	**1.3%**	**0**	**-**	**19**	**0.8%**	**5**	**0.9%**
No cause information entered[5]	**324**	**23.8%**	**26**	**18.7%**	**313**	**19.7%**	**9**	**27.3%**	**602**	**25.5%**	**133**	**24.6%**

Continued overleaf...

NGCC	Royal Marines				RAF			
	NGCC				RE			
	Male		Female		Male		Female	
	n	%	n	%	n	%	n	%
All personnel downgraded	2,281	24.2%	24	26.7%	3,529	14.2%	1,321	30.4%
All principle causes for downgrading	2,365	100.0%	24	100.0%	3,590	100.0%	1,354	100.0%
Infectious and parasitic diseases (A00 - B99)	~	~	0	-	~	~	~	~
Neoplasms (C00 - D48)	15	0.6%	~	~	48	1.3%	18	1.3%
Blood disorders (D50 - D89)	6	0.3%	0	-	9	0.3%	0	-
Endocrine, nutritional and metabolic diseases (E00 - E90)	31	1.3%	0	-	51	1.4%	12	0.9%
Mental and behavioural disorders (F00 - F99)	130	5.5%	~	~	281	7.8%	150	11.1%
Nervous system disorders (G00 - G99)	17	0.7%	~	~	55	1.5%	19	1.4%
Eye and adnexa diseases (H00 - H59)	5	0.2%	0	-	24	0.7%	~	~
Ear and mastoid process diseases (H60 - H95)	71	3.0%	~	~	36	1.0%	~	~
Circulatory system disorders (I00 - I99)	56	2.4%	~	~	92	2.6%	9	0.7%
Respiratory system disorders (J00 - J99)	47	2.0%	0	-	37	1.0%	~	~
Digestive system disorders (K00 - K93)	49	2.1%	0	-	75	2.1%	11	0.8%
Skin and subcutaneous tissue diseases (L00 - L99)	17	0.7%	0	-	33	0.9%	6	0.4%
Musculoskeletal disorders (M00 - M99) and Injuries (S00 - T98)	1,223	51.7%	8	33.3%	1,391	38.7%	372	27.5%
Genitourinary system diseases (N00 - N99)	9	0.4%	0	-	38	1.1%	22	1.6%
Pregnancy, childbirth and the puerperium (O00 - O99)	0	-	0	-	0	-	0	-
Clinical and laboratory findings (R00 - R99)	43	1.8%	0	-	75	2.1%	30	2.2%
Congenital malformations (Q00 - Q99)	~	~	~	~	7	0.2%	~	~
External causes of morbidity and mortality (V01-Y98)	0	-	0	-	~	~	~	~
Factors influencing health status (Z00 - Z99)	19	0.8%	~	~	12	0.3%	218	16.1%
Read code not mapped to ICD-105	**19**	**0.8%**	**0**	**-**	**23**	**0.6%**	**7**	**0.5%**
No cause information entered[5]	**602**	**25.5%**	**3**	**12.5%**	**1,294**	**36.0%**	**467**	**34.5%**

1. Data extracted for latest medical downgrading on DMICP for those on strength as at 1 November 2015.
2. GCC roles defined using Trade information held in JPA.
3. Numbers fewer than five have been suppressed and presented as ~ in accordance with Def Stats Rounding policy. Where there is only one cell in a row or column that is less than five, the next smallest number (or numbers where there are tied values) has also been suppressed so that numbers cannot simply be derived from totals.
4. Please note that these data represents a subset of the Trained UK Regular Armed Forces population.
5. Changes to previously supplied information is annotated with 'r' following changes to the methodology originally used.

C | APPENDIX C: Framework for the development of Physical Employment Standards