Musculoskeletal surgery in Australian Defence Force trainees: Part 2 - risk factors and impact on deployability

S Faulks, D Duncan

Introduction

The cost of recruiting and training a military trainee is substantial. In 1999, Rudzki and Cunningham estimated the cost of recruiting and training a new Australian Defence Force (ADF) member to be $A9000, with a net cost of $A14 245 if they were discharged after 10 weeks.[1] This cost will be significantly higher in 2020 with inflation.

Should a military trainee fail to complete their initial training, there are significant financial and capability losses to the military. Studies in Australian and United States (US) Defence Forces have reported a 5% attrition rate from basic training.[2, 3] Even if basic training was completed, Hoglin (2012) reported that 31% of ADF recruits did not complete their first term of service.[4] A US study estimated that a 4% trainee attrition rate translated to a $US33–57 million lost return on investment (depending on time of discharge).[3] Given the significant investment in the recruitment and training of military trainees, it is of benefit to the ADF and the trainee to minimise any causes of this attrition where possible.

One of the primary purposes of being in the military is to deploy on operations. A military member must be recruited, complete initial training and then maintain physical and medical fitness to be deployable. The fitness of ADF members is represented by their Military Employment Classification (MEC), which communicates the ability of ADF personnel to fulfil their regular duties and deploy on operations.[5] An ADF member's MEC may classify them as Fully Employable and Deployable, Employable and Deployable with Restrictions, Undergoing Rehabilitation, Undergoing Employment Transition, or Medically Unfit for Further Service.[5] Deployability, as communicated by MEC, can be used as an indicator of whether a military recruit has completed initial training.

There is limited evidence regarding the impact of injury on the completion of training in ADF trainees. Pope *et al.* (1999) found that injured ADF trainees were 10 times less likely to complete training than those who had not sustained an injury.[6] This is consistent with studies in foreign defence forces.[6, 7, 8, 9] Injury during basic military training was three times more likely than during other physical activity.[7] Overall, Leggat and Smith (2007) estimate that up to 50% of military recruits suffer injury during basic military training.[8] In the ADF, Allison et al. (2015) found a 34.3% rate of injury during the Army's 80-day recruit training,[2] consistent with another study reporting an injury incidence was 37.6%–46.6%.[9] Over time, this appeared to improve with a 13.9% injury prevalence on the Army Recruit course in a 2015 study.[10] A study in Australian Navy recruits reported a lower limb injury rate of 21.9%.[11] Ross and Woodward (1993) reported a much lower injury incidence of 2.7% in Australian Air Force trainees.[12]

While musculoskeletal injury rates likely influence the rate of musculoskeletal surgery, there are no contemporaneous studies on the impact of musculoskeletal surgery on the completion of training by ADF trainees. There may also be demographic characteristics that predispose to the requirement for musculoskeletal surgery.

This is the second report from a retrospective cohort study examining musculoskeletal surgery in ADF trainees. This paper assesses the employment outcome of ADF trainees undergoing musculoskeletal surgery, which may influence policy regarding suitability for military service and the appropriate military management of injured ADF trainees. It also provides a descriptive analysis of ADF trainees undergoing musculoskeletal surgery, which may allow targeted injury prevention and guide recruitment policy.

Table 1. Rank classifications included in analysis

NATO code	Army	Air Force	Navy
O-2	Lieutenant	Flying Officer	Sub Lieutenant
O-1	Second Lieutenant	Pilot Officer	Acting Sub Lieutenant
	Officer cadet	Officer cadet	Midshipman
E-O4	Lance Corporal		
E-O3	Private (Proficient)	Leading Aircraftman/woman	Able Seaman
E-O2	Private	Aircraftman/woman	Seaman

The purpose of this study was to determine whether ADF trainees who undergo musculoskeletal surgery are less likely to be deployable, according to their MEC, compared to ADF trainees who do not undergo musculoskeletal surgery. A secondary outcome was the investigation of demographic factors of those who underwent musculoskeletal surgery.

Methods

Sample participants

All new patient registrations in the Defence e-Health System (DeHS) from 01 January 2015 to 31 December 2018 were identified. This period was chosen to ensure the required information was available and the consequence of any surgery was likely to be clear.

A proxy of rank was used to identify trainees from the new DeHS user registrations (see Table 1). The uppermost rank of E-O4 or O-2 was determined as those most likely to have been trainees in the period the data covered. This determination excluded specialist officers who enter the ADF at an O-3 level (e.g. medical officers, legal officers, chaplains) and any trainees who were promoted unusually quickly. In Army, specialist officers undergo a truncated initial training course, so this study assumes that the rate of injury is likely lower in this group.

Details of any invoices paid for health services to the trainees were obtained from the Defence Health Services Contracting Team. Services for musculoskeletal surgery as defined by the Medicare Benefits Schedule (MBS) item number recorded on the invoice were identified.[13] The case sample was further refined to exclude surgery that occurred greater than two years after the date of DeHS registration, as it is unlikely that these members were still trainees at the time of surgery (see Figure 1). This exclusion may not capture some Australian Defence Force Academy cadets, who are trainees for up to four years. Surgery for anterior cruciate ligament reconstruction was excluded as it is being examined in a contemporaneous study (DDVA HREC Protocol Number 186-19).

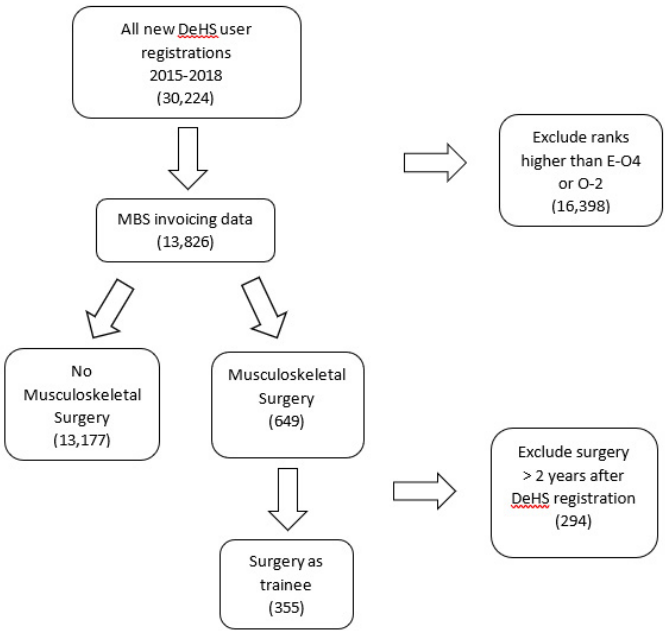

Figure 1. Methodology for obtaining study sample

Ethics

The Departments of Defence and Veterans Affairs Human Research Ethics Committee approved the conduct of this project (approval number 224-20).

Data analysis

Initial data analysis and coding were performed using Microsoft Excel®, and a de-identified sample using allocated study identification numbers was exported to Stata/IC v16 from StataCorp for statistical analysis.

For analysis of the association of surgery with deployability, participants were grouped according

to their MEC at 12 June 2020 as Deployable or Not Deployable. Participants were further grouped into Deployability groups: 'Fully Deployable', 'Deployable with Restrictions', 'Undergoing Rehabilitation', 'Undergoing Employment Transition', and 'Medically Unfit for Further Service'. The association between surgery and deployability was analysed using Pearson's Chi-Squared test. Two sample proportion tests compared the proportion of each Deployability group in the 'Surgery' and 'No Surgery' groups.

Baseline characteristics of the 'Surgery' and 'No Surgery' groups were compared using a two-sample t-test for age, and two sample proportion tests for gender and service. Two sample proportion tests also compared the ages of 'Surgery' and 'No Surgery' groups.

Statistical analysis was conducted using 95% confidence intervals and $p<0.05$ indicating statistical significance.

Results

Baseline characteristics

The analysis of baseline characteristics is reported in Table 2. The mean age of the Surgery group was significantly higher than that of the No Surgery group (26.4 compared to 25.5, $p=0.0041$). This difference was due to a higher proportion of trainees aged between 15–24 years in the No Surgery group (55.4% compared to 45.1%, $^{p}=0.0001$) and a relatively higher representation of trainees in the 25-34 age group in the Surgery group (45.9% compared to 37.7%, $p=0.0017$). For the ADF trainees who had surgery, 91% fell within the 15–24 or 25–34 age groups (160 and 163 trainees, respectively).

There was no significant difference in the genders of ADF trainees who underwent musculoskeletal surgery compared to those who did not. Army represented 65.9% of the Surgery group but only 57% of the No Surgery group ($p=0.0008$), and there were proportionally fewer Navy trainees in the Surgery group than the No Surgery group (17.2% and 23.2% respectively, $p=0.0071$).

Association between surgery and employment outcome

There was a statistically significant association between musculoskeletal surgery and deployability, with the Surgery group more likely to have a Non-Deployable MEC ($p=0.0001$). Proportionally, there

Table 2. Baseline characteristics of ADF trainees between 2015–2018, comparing those who did not undergo musculoskeletal surgery with those who underwent musculoskeletal surgery.

	No Surgery			**Surgery**			**p value**
Mean age (years)	**25.5 (95% CI 25.4 to 25.6)**			**26.4 (95% CI 25.8 to 26.9)**			**0.0041***
	Number	%	95% CI	Number	%	95% CI	
Age group							
15–24							
25–34	7306	55.4	54.6 to 56.3	160	45.1	39.9 to 50.2	0.0001*
35–44	4970	37.7	36.9 to 38.5	163	45.9	40.7 to 51.1	0.0017*
45–54	728	5.5	5.1 to 5.9	27	7.6	4.9 to 10.4	0.0919
55+	159	1.2	1.0 to 1.4	4	1.1	0.03 to 2.2	0.8918
	14	0.1	0.05 to 0.2	1	0.3	-0.3 to 0.8	0.3267
Gender							
Female	3257	24.7	24.0 to 25.5	100	28.2	23.5 to 32.9	0.1375
Male	9920	75.3	74.5 to 76.0	255	71.8	67.2 to 76.5	
Service							
Army	7507	57.0	56.1 to 57.8	234	65.9	61.0 to 70.9	0.0008*
Air Force	2602	19.8	19.1 to 20.4	59	16.9	13.0 to 20.8	0.1826
Navy	3,68	23.2	22.5 to 24.0	62	17.2	13.3 to 21.1	0.0071*

***** statistically significant, $p<0.05$

Table 3. Proportion of ADF trainees between 2015–2018 with each employment outcome, comparing those who did not undergo musculoskeletal surgery with those who underwent musculoskeletal surgery

	No Surgery (%)	Surgery (%)	p value
Fully Deployable	84.6	72.1	<0.0001*
Deployable with Restrictions	1.4	2.3	0.1578
Undergoing Rehabilitation	12.7	22.5	<0.0001*
Undergoing Employment Transition	0.4	1.7	0.0002*
Medically Unfit for Further Service	0.9	1.4	0.3284

were significantly fewer trainees who were Fully Deployable in the Surgery group (p<0.0001), and significantly more who were Undergoing Rehabilitation (p<0.0001) and Undergoing Employment Transition (p=0.0002) (Table 3).

Discussion

Musculoskeletal surgery and employment outcome

This retrospective study examined the association between musculoskeletal surgery in ADF trainees and their deployability. The results of this study demonstrated a statistically significant negative association between musculoskeletal surgery as a trainee and deployability. It is expected that those undergoing surgery require a period of rehabilitation, so the higher proportion of trainees classified as Undergoing Rehabilitation in the Surgery group is not unexpected. As this study used a snapshot of deployability at a single point in time, it is unknown whether those Undergoing Rehabilitation returned to deployability at the end of their rehabilitation, or were found Medically Unfit for Further Service. A longer duration of follow-up in future studies may provide clarification on this.

Considering that 3.1% of ADF trainees who underwent musculoskeletal surgery were classified as either Undergoing Employment Transition or found Medically Unfit for Further Service, this represents a significant loss on investment in recruitment and training for the ADF. It may be that trainees that undergo musculoskeletal surgery should be assessed earlier to determine whether they are likely to be non-deployable long term and managed more appropriately outside of the ADF to prevent further injury. More research is required to develop robust criteria to identify such trainees.

Risk factors for musculoskeletal surgery

Age appeared to be a risk factor for musculoskeletal surgery, with a statistically significant increased mean age in the Surgery group, with overrepresentation of the 25–34 years age group. However, there was no significant difference in trainees aged over 35 years. This is broadly consistent with studies in the US and Norwegian military trainee populations, which found an association between injury rate and older age.[14-16] Interestingly, the Defence Census reports 37% of the permanent ADF population is aged between 25–34 years, which is close to the proportion in the No Surgery group of trainees.[17] This suggests that age should be considered when implementing training to prevent injury and subsequent surgery in older age groups.

Previous studies have found female gender to be a risk factor for injury in Australian and international military trainees.[12, 15, 16, 18-23] This study found that females were represented in broadly equal proportions in the Surgery and No Surgery groups. There was a higher proportion of females in both trainee groups compared with the ADF overall (15.1% female). This may reflect a drive towards increasing the number of female military recruits. It is unclear whether the injuries females experienced were less likely to require surgery or whether there were different injury management practices compared to males; further research is required to investigate this inconsistency.

Army trainees represented a higher proportion of the Surgery group than Air Force and Navy. This may reflect the nature of basic training in each service, with a higher physicality in Army basic training exposing those trainees to injury requiring musculoskeletal surgery. Further analysis into the relative impact on different genders within each service would provide useful insight into injury types and training regimens.

Limitations

This study had a number of limitations. First, the selection process made assumptions about a trainee's rank and time in training, which may have excluded some trainees from analysis. The exclusion

of anterior cruciate ligament repair impacted the strength of the findings. The identification of particular surgeries was reliant on the coding of MBS item numbers, which may not have been completely accurate. Finally, the time frame for the study meant a definitive outcome from the surgery had not been reached for some trainees. Hence, it is still not completely clear whether there is an association between musculoskeletal surgery and deployability.

Conclusion

These preliminary findings suggest an association between musculoskeletal surgery and deployability in military trainees, with a higher risk of surgery with increased age and with Army service. Future studies with longer follow-up may clarify this association in more depth and determine causal factors to inform recruitment and retention policies.

Corresponding Author: Sally Faulks, sally.faulks@defence.gov.au
Authors: S Faulks[1,2], D Duncan[1,2]
Author Affiliations:
1 Joint Health Command
2 Royal Australasian College of Medical Administrators

References

1. Rudzki S, Cunningham M. The effect of a modified physical training program in reducing injury and medical discharge rates in Australian Army recruits. Military Medicine. 1999;164:648-52.
2. Allison S, Cohen B, Zambraski E, Jaffrey M, Orr R. Predictive models to estimate probabilities of injuries, poor physical fitness, and attrition outcomes in Australian Defence Force Army Recruit Training. Technical Report T16-6: USARIEM; 2015.
3. Swedler D, Knapik J, Williams K, Grier T, Jones B. Risk factors for medical discharge from United States Army Basic Combat Training. Military Medicine. 2011;176(10):1104-10.
4. Hoglin P. Early separation in the Australian Defence Force. Monograph submitted in fulfillment of 2011 Chief of the Defence Force Scholarship: Commonwealth of Australia; 2012.
5. Department of Defence. Volume 1, Part 6, Chapter 2 - Medical Employment Classification System. Defence Health Manual: Defence Publishing Service; 2014.
6. Pope R, Herbert R, Kirwan J, Graham B. Predicting attrition in basic military training. Military Medicine. 1999;164(10):710-4.
7. Sherrard J, Lenne M, Cassell E, Stokes M, Ozanne-Smith J. Injury prevention during physical activity in the Australian Defence Force. Journal of Science and Medicine in Sport. 2004;7(1):106-17.
8. Leggat P, Smith D. Military training and musculoskeletal disorders. Journal of Musculoskeletal Pain. 2007;15(2):25-32.
9. Rudzki S. Injuries in Australian Army recruits. Part I: Decreased incidence and severity of injury seen with reduced running distance. Military Medicine. 1997;162:472-6.
10. Dawson G, Broad R, Orr R. The impact of a lengthened Australian Army recruit training course on recruit injuries. Journal of Military and Veterans Health. 2015;23(2):14-9.
11. Bonanno D, Murley G, Munteanu S, Landorf K, Menz H. Effectiveness of foot orthoses for the prevention of lower limb overuse injuries in naval recruits: a randomised controlled trial. British Journal of Sports Medicine. 2018;52:298-302.
12. Ross J, Woodward A. Risk factors for injury during basic military training: is there a social element to injury pathogenesis? Journal of Occupational Medicine. 1994;36:1120-6.
13. Department of Health. MBS Online: Medicare Benefits Schedule: Australian Government; 2020 [updated 20 September 2020]. Available from: http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/Home.
14. Bulzacchelli M, Sulski S, Rodriguez-Monguio R, Karlsson L, Hill M. Injury during Army basic combat training: a systematic review of risk factor studies. American Journal of Preventive Medicine. 2014;47(6):813-22.
15. Heir T. Musculoskeletal injuries in officer training - one-year follow-up. Military Medicine. 1998;163(4):229-33.

16. Nye N, Pawlak M, Webber B, Tchandja J, Milner M. Description and rate of musculoskeletal injuries in Air Force basic military trainees 2012-2014. Journal of Athletic Training. 2016;51(11):858-65.
17. Department of Defence. Defence Census 2015: Public Report. Canberra: Australian Government; 2016.
18. Kaufman K, Brodine S, Shaffer R. Military training-related injuries: surveillance, research, and prevention. American Journal of Preventive Medicine. 2000;18(S3):54-63.
19. Billings C. Epidemiology of injuries and illnesses during the United States Air Force Academy 2002 Basic Cadet Training program: documenting the need for prevention. Military Medicine. 2004;169(8):664-70.
20. Snedecor M, Boudreau C, Ellis B, Schulman J, Hite M, Chambers B. U.S. Air Force recruit injury and health study. American Journal of Preventive Medicine. 2000;18(3S):129-40.
21. Bell N, Mangione T, Hemenway D, Amoroso P, Jones B. High injury rates among female army trainees: a function of gender? American Journal of Preventive Medicine. 2000;18(S3):141-6.
22. Knapik J, Sharp M, Canham-Chervak M, Hauret K, Patton J, Jones B. Risk factors for training-related injuries among men and women in basic combat training. Medicine & Science in Sports & Exercise. 2001;33(6):946-54.
23. Jones B, Bovee M, Harris J, Cowan D. Intrinsic risk factors for exercise-related injuries among male and female army trainees. The American Journal of Sports Medicine. 1993;21(5):705-10.