Introduction of an Applicant Job-Related Task Assessment and the Effects on the Health and Fitness of Police Recruits

Lockie, Robert G.; Orr, Rob Marc; Kennedy, K.; Jay Dawes, J.

BOND UNIVERSITY

International Physical Employment Standards Conference Program

23-26 February, 2023

THURSDAY, 23rd FEBRUARY, 2023		
Time	Topic/Content	Location
4.00pm - 6.00pm	Registration (Welcome BBQ)	Faculty of Health Sciences and Medicine - Gregor Heiner Foyer

FRIDAY, 24th FEBRUARY, 2023	For oral presentations themes and presenters see page 4	
Time	Topic/Content	Location
8.00am	Registration	Basil Sellers Foyer
8.30am - 9.30am	• Welcome to PES by Dr Rob Orr • Welcome to Country Elder Uncle John Graham • Jellurgal Aboriginal Dance Performance • Welcome by Bond University Vice Chancellor and President Professor Tim Brailsford	Room 12 - Basil Sellers Theatre
9.30am - 10:20am	Leading Keynote – Commissioner Georgeina Whelan ACT Emergency Services Agency (Australia)	Room 12 - Basil Sellers Theatre
10.30am - 11.40am	Oral Presentations Theme: Developing PES 1	Room 12 - Basil Sellers Theatre
11.40am - 12.00pm	Break	Princeton Room
12.00pm - 1.10pm	Oral Presentations Theme: Developing PES 2	Room 12 - Basil Sellers Theatre
1.10pm - 2.00pm	Lunch Break	Princeton Room
2.00pm - 3.10pm	Oral Presentations Theme: Developing PES 3	Room 12 - Basil Sellers Theatre
3.10pm - 3.30pm	Break	Princeton Room
3.30pm - 4.30pm	Keynote – Rachel Blacklock / Leslie Frei Canadian Forces Morale & Welfare Services (Canada)	Room 12 - Basil Sellers Theatre
4.30pm	End of day 1 Please enjoy everything that the Gold Coast has to offer! See our website for suggestions. bond.edu.au/research/research-bond/IPES-conference/about-the-gold-coast	

SATURDAY, 25th FEBRUARY, 2023	For oral presentations themes and presenters see page 5-6	
Time	Topic/Content	Location
8.00am	Registration	Basil Sellers Foyer
8.30am - 9.20am	Keynote – COL Anne Fieldhouse, OBE AD Med British Army (United Kingdom)	Room 12 - Basil Sellers Theatre
9.30am - 11.10am	Oral Presentations Theme: Relationships and Comparisons of Task and Tests	Room 12 - Basil Sellers Theatre
11.10am - 11.30am	Break	Princeton Room
11.30am - 12.30pm	Thematic Poster Presentations Theme 1: Developing and Validating Standards Theme 2: Tasks and Physical Demands	Princeton Room
12.30am - 1.00pm	"Be Active" Campus / Lake Walk	Bond Campus
1.00pm - 2.00pm	Lunch Break	Princeton Room
2.00pm - 3.10pm	Oral Presentations Theme: Health and Fitness 1	Room 12 - Basil Sellers Theatre
3.10pm - 3.30pm	Break	Princeton Room
3.30pm - 4.30pm	All you need is PES: The Interactive Argument Debate	Room 12 - Basil Sellers Theatre
4.30pm - 5.00pm	Aussie Trivia Event	Room 12 - Basil Sellers Theatre
5.00pm	End of day 2	
6.00pm - 8.00pm	Conference Delegate Networking Reception	Princeton Room

SUNDAY, 26th FEBRUARY, 2023	For oral presentations themes and presenters see page 7	
Time	Topic/Content	Location
8.30am	Registration	Basil Sellers Foyer
9.00am - 10.00am	Keynote – Dr Michael Drew Director of Health Research, Department of Defence (Australia)	Room 12 - Basil Sellers Theatre
10.00am - 11.10am	Oral Presentations Theme: Paramedicine	Room 12 - Basil Sellers Theatre
11.10am - 11.30am	Break	Princeton Room
11.30am - 12.40pm	Oral Presentations Theme: Health and Fitness 2	Room 12 - Basil Sellers Theatre
12.40pm - 1.30pm	Lunch Break	Princeton Room
1.30pm - 2.40pm	Oral Presentations Theme: Recruiting and Retention	Room 12 - Basil Sellers Theatre
2.50pm - 3.50pm	Panel: Into the Future - The Next Generation	Room 12 - Basil Sellers Theatre
3.50pm - 4.10pm	Closing address and handover to the next host	Room 12 - Basil Sellers Theatre
4.10pm - 4.30pm	Farewell Drinks and Cheese	
4.30pm	End of PES 2023	

ORAL PRESENTATIONS DETAILS

FRIDAY, 24th FEBRUARY, 2023

Time	Theme	Chair
10.30am - 11.40am	Developing PES 1	Dr Ben Schram

A profile of occupational tasks performed by mounted police officers
Elisa Canetti, Australia

Establishing a Minimum Distance Standard for a Medicine Ball Proxy Test Based on a Suspect Apprehension Task Simulation within a New Police Physical Employment Standard: A Preliminary Analysis
Martin Poirier, Canada

Development of an Evidence-Based Swimming Representative Military Task to Assess Swimming Competency in the British Army
Sam Blacker, United Kingdom

Physical Demands of Training Task of the Canadian Clearance Divers to Develop a Selection Physical Fitness Evaluation
Etienne Chasse, Canada

Cardiorespiratory endurance task demands across the Royal Australian Air Force
Greg Carstairs, Australia

12.00pm - 1.10pm	Developing PES 2	Dr Rod Pope

Quantification of workload during Marine Corps Recruit Depot San Diego boot camp
Karen Kelly, United States of America

Quantifying the Essential Tasks of Offshore Wind Technicians
Gemma Milligan, United Kingdom

Manual handling task demands across the Royal Australian Air Force
Greg Carstairs, Australia

Time-Motion Analysis of Neutral-buoyancy Lab runs to simulate micro-gravity extra-vehicular activities
Etienne Chasse, Canada

Protocol for identifying and characterising critical physical tasks in the Swedish Armed Forces (SwAF).
Andreas Monnier, Sweden

2.00pm - 3.10pm	Developing PES 3	Dr Joanne Caldwell

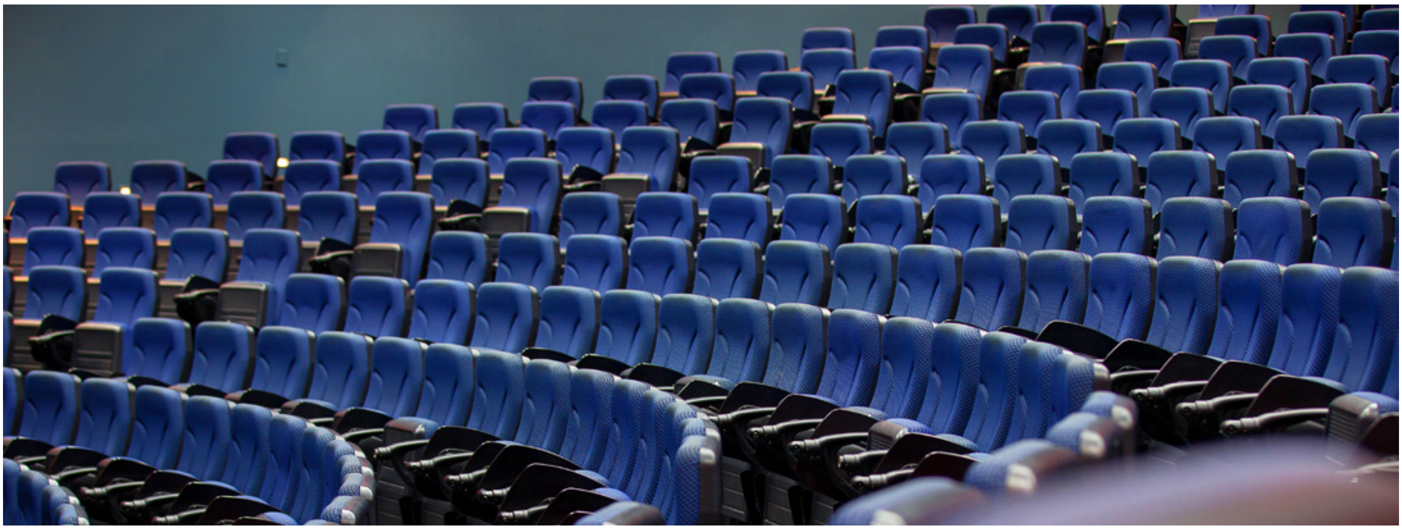
A Job Task Analysis of the Authorised Firearms Officer – Counter Terrorism (AFO-CT) National Role Profile
Steven Powell, United Kingdom

A Novel Approach to Characterizing and Quantifying a Suspect Apprehension in the Development of a Modernized Physical Employment Standard for a National Police Force
Martin Poirier, Canada

The bookmark method to establish minimum performance standards for intensive care flight paramedics performing helicopter winch rescue.
Benjamin Meadley, Australia

Occupationally-Specific, Operationally-Relevant Physical Fitness Tests and Standards for US Air Force Security Forces Airmen
Neal Baumgartner, United States of America

The Development and Validation of a Netball Specific Fitness Test for International Umpires
Gemma Milligan, United Kingdom



ORAL PRESENTATIONS DETAILS

SATURDAY, 25th FEBRUARY, 2023

Time	Theme	Chair
9.30am - 11.10am	Relationships and Comparisons of Task and Tests	Dr Jace Drain

Lower-body Muscular Power Predicts Performance on Urban Combat Simulation
Ojanen Tommi, Finland

Relationships and Predictive Capabilities of Two Different Applicant Test Batteries with Performance in a Job-Specific Physical Ability Exit Examination in Law Enforcement Recruits
Joseph Dulla, United States of America

The Development of Normative Fitness Data and Analysing the Relationships Between 20MSFT and 2.4-Km Run Performance in Australian Police Recruits
Patrick Campbell, Australia

Heart Rate Variability Profile Changes Associated with Sleep, Less-lethal Explosive Device Exposure, and Fear of Heights Training in Specialist Police Selection
Colin Tomes, Australia

Predicting Academy Graduation in Firefighter Trainees via Physical Fitness Testing
Robert Lockie, United States of America

A Comparison of Two Law Enforcement Marksmanship Assessments
Rob Orr, Australia

Associations Between Soldiers Physical Fitness and Occupational Task Course Performance.
Ojanen Tommi, Finland

THEMATIC POSTER PRESENTATIONS

11.30am - 12.30pm	Developing and Validating Standards	Dr Rob Orr

The Development of a Physical Employment Standard for the Authorised Firearms Officer – Counter Terrorism (AFO-CT) National Role Profile
Steven Powell, United Kingdom

An Age And Gender Free Physical Employment Standard For Royal Navy Seafarers: An Observational Objective Job Analysis Of Criterion Role Related Tasks
Joe Hogan, United Kingdom

Using computer vision to quantify movement competency during physical employment testing: An example using the Ottawa Paramedic Physical Abilities Test
Steven Fischer, Canada

11.30am - 12.30pm	Tasks and Physical Demands	Dr Robert Lockie

Paramedic physical fitness requirements and physical preparation of students for the paramedic role: A narrative review.
Samantha Sheridan, Australia

Development of a Novel Incremental Lift Representative Military Task for the British Army non-Ground Close Combat Physical Employment Standards
Anne Fieldhouse, United Kingdom

Comparison of One- and Two-Person Simulated Casualty Drag Performance
Sam Blacker, United Kingdom

Comparison of historical versus proposed physical employment standards for flight paramedics performing helicopter winch rescue.
Joanne Caldwell, Australia

Comparison of physical demanding paramedic work tasks between an Australian and Canadian ambulance service
Jacinta Waack, Australia

An Age And Gender Free Physical Employment Standard For Royal Navy Seafarers: A Physical Demands Analysis Of Critically Demanding And Essential Seafaring Tasks
Joe Hogan, United Kingdom

Performance variations between 3 different backpack systems: A Pilot Study
Rob Orr, Australia

ORAL PRESENTATIONS DETAILS		
SATURDAY, 25th FEBRUARY, 2023		
Time	Theme	Chair
2.00pm - 3.10pm	Health and Fitness 1	Ms. Helen Kilding

What are the personal, lifestyle and physical performance characteristics of New Zealand Army Recruits entering basic training?
Narelle Hall, Australia

Incidences and Causative Factors of Lower Limb Injuries in the New Zealand Army
Jacques Rousseau, New Zealand

Introduction of an Applicant Job-Related Task Assessment and the Effects on the Health and Fitness of Police Recruits
Robert Lockie, United States of America

Law Enforcement Recruit Fitness Changes across the Fitness Spectrum
Danny Maupin, Australia

Injuries Following Implementation Of A Progressive Load Carriage Program In United States Marine Corps Training
Karen Kelly, United States of America

3.30pm 4.30pm	All you need is PES: The Interactive Argument Debate	Dr Gemma Milligan

ORAL PRESENTATIONS DETAILS

SUNDAY, 26th FEBRUARY, 2023

Time	Theme	Chair
10.00am - 11.10am	Paramedicine	Dr Sandy MacQuarrie

Connecting the dots between physical demands, physical employment testing and physical fitness in a paramedicine context
Samantha Sheridan, Australia
Sandy MacQuarrie, Australia
Renee MacPhee, Canada
Steve Fischer, Canada

Time	Theme	Chair
11.30am - 12.40pm	Health and Fitness 2	Dr Andy Siddall

Lower Limb Injury Prevention in the New Zealand Army Through Targeted Foot Wear Investigation
Jacques Rousseau, New Zealand

Isokinetic Shoulder Strength in Tactical Populations: A Critical Review
Michael Wilkinson, Australia

Ventilatory and Respiratory Muscle Function of British Army Infantry Soldiers is Similar to Physically Active Civilians at Rest and in Response to Torso-Borne Thoracic Load Carriage Activities
Josh Osofa, United Kingdom

Effects of a Single-Day Pre-Academy Physical Test Education Session on Physical Fitness Scores of Police Candidates
Ben Schram, Australia

Developing National Level Personnel Policy for Physical Performance and Body Composition Tests
Michael McGurk, United States of America

Time	Theme	Chair
1:30pm - 2:40pm	Recruiting and Retention	Dr Sam Blacker

The Benefits of a Modular Physical Employment Standards Approach: Modifications to Accommodate Change in Ammunition Handling Job-Tasks
Julie Draper, United Kingdom

Exploring recruiting opportunities - adjusting physical fitness standards for Army recruits
Jace Drain, Australia

Profile of Two Different Applicant Test Batteries with Regards to Sex and Age in Successful Law Enforcement Applicants
Joseph Dulla, United States of America

The Incidence and Risk Factors for the Development of Stress Fractures in Military Recruits and Qualified Personnel: A Rapid Review
Patrick Campbell, Australia

A profile of injuries suffered by female soldiers serving in the Australian Army.
Ben Schram, Australia

Developing a Return-to-Work Assessment for an Injured Police Officer: A Case Report
Traci Tauferner, United States of America

Time	Theme	Chair
2.50pm - 3.50pm	Panel: Into the Future - The Next Generation	Dr Rob Orr

British Army Physical Employment Standards Next Steps; Building on Implementation to Further Inform Evidence-Based Policy
Julie Draper, United Kingdom

Research Failing The Public Relations Battle: US Army ACFT As Lessons Learned
Michael McGurk, United States of America

Aspiration vs reality; recruiting and maintaining our future forces
Jace Drain, Australia

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The registration desk will be situated in the Basil Sellers Foyer. This will be manned during pre-conference registration and during each designated breaks in the program.

2. Program
The conference organising committee reserve the right to change the program at any time without notice. Please note that this program was accurate at the time of printing.

3. Lost and Found
There will be a Lost and Found located at the registration desk during the conference.

4. Conference Venue
The plenary room is located in the Basil Sellers Theatre & Foyer situated in Building 6, Level 3, Room 12. Exhibitors and catering will be served in the Princeton Room in Building 6, Level 3. Please refer to building layout map below for more information.

5. Catering
The conference will provide: Arrival tea and coffee, morning tea, lunch and afternoon tea during the designated breaks and is included in your registration. Dietary requirements are collected during registration process and will be catered for accordingly.

6. Luggage Storage
A luggage room has been reserved for the conference. Please see registration desk for more details.

7. Instructions for Speaker Presentations
Please refer to the conference speaker guidelines that have been communicated to the presenters via email. The speaker preparation centre is located in Building 6, Level 2 Room 18.

8. Internet
Complimentary wifi is available. Details available upon registration.

9. Parking
Complimentary parking is available in PG9 & PG10 carparks.

10. Name Badges
For security reasons, we ask all delegates to wear their names badges on entry and within the conference venue in order to access the program and events. Presentations will only be accessible to registered delegates. The lanyard provided will also hold your ticket for the conference delegate networking event.

11. Dress Guidelines
The attire for attendees and presenters at the conference is smart casual.

12. Security
For the University's Public Safety and Security Office please contact: 5595 1234. The office is located in Building 10.

13. Filming/Photography
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Please be aware that the use of mobile phones can be distracting to attendees and presenters. Delegates are asked to turn off their mobile phones or set them to silent when in sessions.

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The nearest ATM to the conference venue is located at the entrance of Building 8 - North Tower Student Accommodation next to the Security Office.

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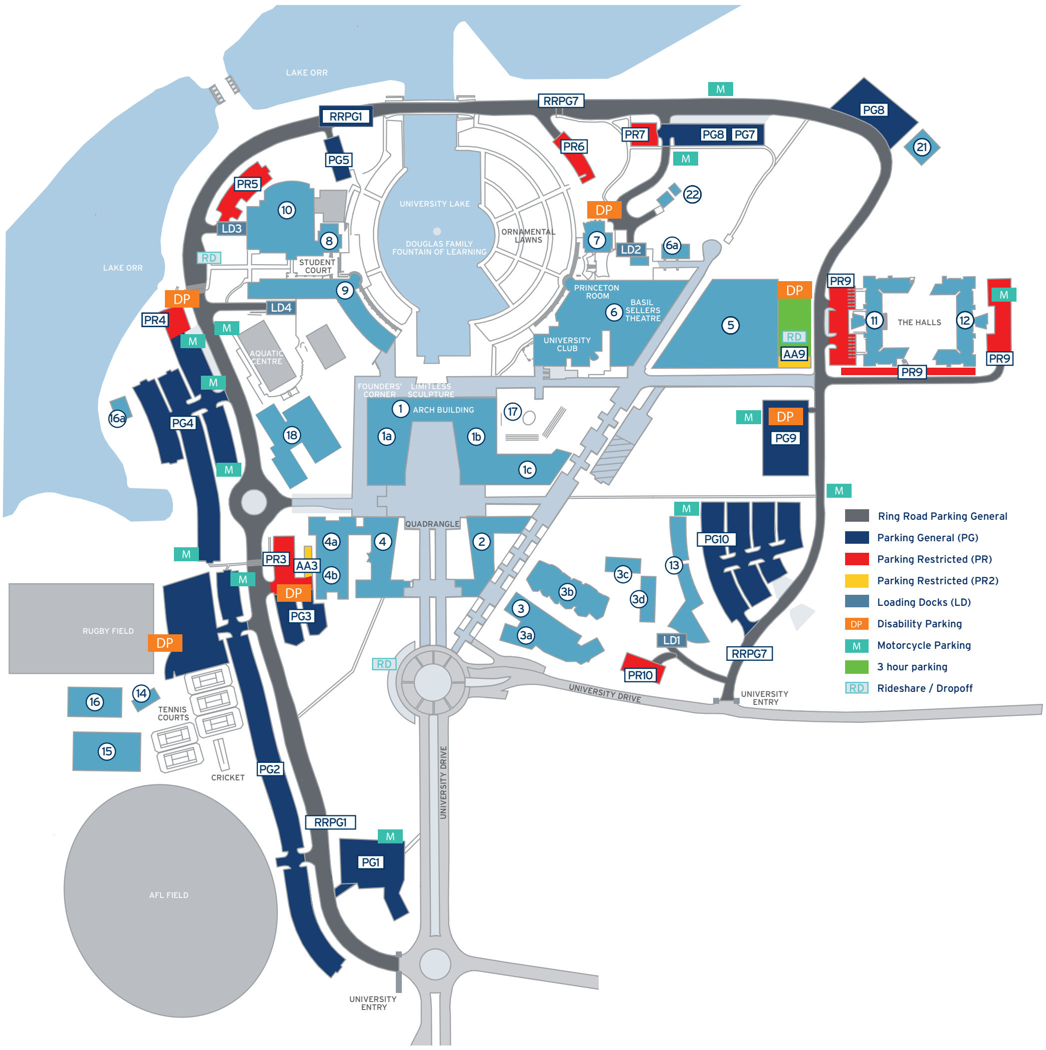

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2023

The 4th International Physical Employment Standards (IPES) Conference

Friday, 24 February - Sunday, 26 February 2023

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**Everything was so new –
the whole idea of going into space
was new and daring. There were no
textbooks, so we had to write them.**

”

Katherine Johnson

OCCUPATIONAL-SPECIFIC, OPERATIONALLY-RELEVANT PHYSICAL FITNESS TESTS AND STANDARDS FOR US AIR FORCE SECURITY FORCES AIRMEN

Baumgartner, N.[1], Flerlage, E.M.[1], Frost, M.J.[1], Hale, K.N.[1], Rhodes, A.K.[1] & Welch, B.J.[1]

[1.] USAF Exercise Science Unit, Joint Base San Antonio-Randolph, Texas, United States of America.

PURPOSE: The current United States (US) Air Force general physical fitness test (PFT) does not necessarily reflect military task achievement for physically demanding specialties, *e.g.*, Security Forces (SF). The aim of this study was to develop an occupational-specific, operationally relevant (OSOR) PFT and standards for SF. **METHODS**: A physical demands analysis was conducted through focus groups, SF Airmen's assessment of duty tasks, observations of SF operations, and interviews of SF leaders. Analysis identified critical physical tasks (CPTs) used to develop eight physical task simulations (PTSs). Subjects (n = 125, n = 25 female; mean age = 25.7±6.1 years; mass = 80.1±14.0kg; stature = 173.9±9.6cm) completed eight PTSs and 25 PFT candidate components to determine optimal PFT battery for predicting operational physical task success. Experienced SF Airmen reviewed PTS data to determine minimum effective times for task success. Prototype PFT was validated via a separate group of subjects (n = 37, n = 8 female; age = 28.8±5.7 years; mass = 80.6±12.6kg; stature = 171.9±8.0cm) and implemented at 252 worldwide SF units. **RESULTS**: Process narrowed 1286 occupational tasks to 125 preliminary physical tasks to 25 CPTs and identified 11 PF components and 14 physical movement patterns necessary to perform CPTs. Final four PFT components (Table 1) selected objectively per primary criteria: predictive validity of operational success, PF component breadth, physical movement pattern breadth, ease of administration, resource demand, and subject skill requirements. Validation of prototype PFT and standards elicited a 95.6% classification accuracy. Implementation produced a 94.2% feasibility rate. **RELEVANCE**: This study proved efficacious for developing a viable PFT that addresses all OSOR SF CPTs. Recommend official use at US Air Force SF units to ensure operational physical readiness.

Table 1: Final PFT Components in order: Run – Multi-Seg 1 – Med Ball Toss – Multi-Seg 2.

Run 800m	Multi-Segment 1 (in 13.5kg vest)	Medicine Ball Toss 9.1kg	Multi-Segment 2
	Arm release push-ups 10 repetitions	Sum of back, side, log tosses	Sandbag (13.6kg) squat-lift-rotate movement 50 repetitions
	Agility drill 5 x 4.6m (22.9m)		Medicine ball (9.1kg) toss and run 2 x 15m (30m)
	Sandbag (45.4kg) ambulatory movement 4 x 15m (60m)		Row ergometer 1000m
			Farmer's carry (2 x 13.6kg) sandbags 6 x 15m (90m)

The views expressed in this presentation are those of the authors, and do not necessarily reflect official U.S. Government, Department of Defense, or US Air Force positions or policies.

DEVELOPMENT OF AN EVIDENCE-BASED SWIMMING REPRESENTATIVE MILITARY TASK TO ASSESS SWIMMING COMPETENCY IN THE BRITISH ARMY

Blacker, S.[1], Needham-Beck, S.[1], Maroni, T.[1], Walker, F.[1], Vine, C.[1], Moore, D.[1], Draper, J.[2], Alexander, B.[2] & Myers, S.[1]

[1] Occupational Performance Research Group, Institute of Sport, Nursing and Allied Health, University of Chichester, United Kingdom: [2] Army Headquarters, Andover, United Kingdom

PURPOSE: The Job Task Analysis (JTA) which informed the development of the new British Army Physical Employment Standards (PES) identified job-tasks conducted in and around water. However, a role-related swimming assessment as part of PES was not initially feasible to implement. Therefore, the aim of this study was to conduct a new JTA to specifically evaluate tasks working in and around water to inform the development of a new swimming Representative Military Task (RMT). **METHODS:** Fifteen workshops were conducted to engage with all British Army role-groups to identify and describe job-tasks conducted in or around water. These job-task descriptors were used to produce an online survey; completed by at least 5% of each role-group (respondents=5376). Observations of the most complex tasks were completed during daily work and training. An ergonomic evaluation was conducted to describe the physical actions performed and equipment used, in the job-tasks to inform the development of the swimming RMT. **RESULTS:** The JTA identified and defined five common military swimming tasks (applicable to all role-groups) and 33 role specific swimming tasks (unique to individual role-groups). Seven water-based physical actions were identified in the job-tasks: full immersion in water, treading water/staying afloat, removing personal equipment, wading, swimming, using floatation aids, climbing unaided out of the water. The resultant RMT was designed to reflect these physical actions. The protocol requires participants, wearing uniform (jacket and trousers) and empty webbing, to enter the water (submerge and surface), stay afloat and remove webbing, swim 50 m and stay afloat again for up to 10 minutes. **RELEVANCE:** Using a JTA to develop a swimming RMT has provided an assessment of the minimum role-related water-based competency for British Army personnel. The next phase of this research was to gather normative data in recruits

COMPARISON OF ONE- AND TWO-PERSON SIMULATED CASUALTY DRAG PERFORMANCE

Blacker, S.[1], Vine, C.[1], Doherty, C.R.[1], Walker, F.[1] & Myers, S.[1]

[1]Occupational Performance Research Group, Institute of Sport, Nursing and Allied Health, University of Chichester, United Kingdom

PURPOSE: The ability to successfully drag a casualty to safety is a critical task for individuals in the military, emergency services, and other physically demanding occupations. The British Army's Physical Employment Standards (PES) includes a simulated casualty drag using a 110kg drag bag. However, given that casualty drag tasks can be performed alone or in pairs, a paucity of data exists regarding the comparison between one and two-person casualty drags. Therefore, this study sought to establish whether the demands of a one-person 55kg simulated casualty drag is representative of the demands of a two-person 110kg simulated casualty drag. **METHODS:** Twenty physically active males completed up to 12, 20m casualty drags (using a drag bag) on a grassed sports pitch; comprising of one-person 55 and 110kg drags, and two-person forward facing (FWD) and backwards facing (BWD) 110kg drags. Time to complete, and the forces exerted were measured for each drag iteration. **RESULTS:** On average, the two-person 110kg BWD drag was completed approximately 32% slower than the FWD iteration ($W_{(26)}$=0.00, p<0.001). For the two-person 110kg FWD and BWD drags, the difference in average force contribution between individuals completing the drag was 8.1±5.3% and 7.7±5.1%, respectively. When comparing the average force across each participant's 55kg drags with their average force contribution during all their two-person iterations, statistical analysis indicated that the forces were statistically equivalent (FWD: $t_{(17)}$=1.794, p=0.045; BWD: $t_{(16)}$=3.3780, p<0.001). **RELEVANCE:** These data demonstrate that the individual demands of a two-person 110 kg casualty drag are appropriately represented by a one-person 55 kg casualty drag. However, individual differences in contributions towards a two-person simulated casualty drag were evident. Appropriate strength and conditioning training should therefore be implemented where possible to negate differences in contributions towards a two-person casualty drag.

COMPARISON OF HISTORICAL VERSUS PROPOSED PHYSICAL EMPLOYMENT STANDARDS FOR FLIGHT PARAMEDICS PERFORMING HELICOPTER WINCH RESCUE

Caldwell, J.[1,2] & Meadley, B.[1,3]

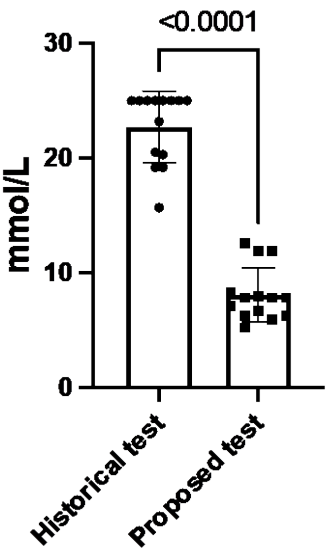
[1]Paramedic Health and Wellbeing Research Unit, Monash University, Victoria, Australia; [2]Department of Physiology, Monash University, Victoria, Australia; [3]Ambulance Victoria, Victoria, Australia

Ambulance Victoria Research Governance Approval: FOL/18/2802

PURPOSE: Specialist paramedics working in helicopter search and rescue teams undertake physically demanding winch rescues over land and in water. Historical assessments were not developed using established physical employment standards (PES) methodology. The aim of this study was to compare the physiological demands of historical land and water-based selection tests with new tests developed via established PES methodology. **METHODS:** Candidates undergoing selection to the role of flight paramedic (n=14: age=37±5yrs, BMI=26±4kg.m^2) had

heart rate, rate of perceived exertion (RPE_{6-20}) and capillary blood lactate recorded during performance of the existing physical tests on land and in water. These data were compared to the same physiological variables captured in qualified and experienced paramedics (n=14: age=44±5yrs, BMI=25±3kg.m^2,) during development of new land and water tests. **RESULTS:** For the land rescue task, task duration (existing=17±2min vs proposed=7±2min, p<0.05), maximum heart rate (existing=186±13bpm vs proposed=173 ±11bpm, p<0.05), and blood lactate (existing=23±3mmol/L vs proposed=8±2mmol/L, p<0.05, Figure 1) were significantly higher in the existing test compared to the proposed tests. For the water rescue task, task duration (existing=12±2min vs proposed=10±1min, p<0.05) was longer in the existing test, but maximum heart rate (existing=166±18bpm vs proposed=167±15bpm, p=0.90), blood lactate (existing=11±4mmol/L vs proposed=11±4mmol/L, p=0.90) did not differ significantly. RPE_{6-20} did not differ between groups for either water or land. (Figure 1) **RELEVANCE:** The historical land-based physical tests for helicopter rescue paramedics differed significantly from the proposed scientifically developed tests, however the water-based test had a similar duration and generated similar physiological strain. Continued use of tests that have not been developed via established scientific methodologies risks eliminating candidates that may be suitable to work in the role, and conversely, including candidates that are not suitable.

Figure 1: Capillary blood lactate comparison for the historical test versus the scientifically developed test for land winch rescue



*Lactate monitor maximum value = 25mmol/L

THE DEVELOPMENT OF NORMATIVE FITNESS DATA AND ANALYSING THE RELATIONSHIPS BETWEEN 20MSFT AND 2.4KM RUN PERFORMANCE IN AUSTRALIAN POLICE RECRUITS

Campbell, P.[1,2], Maupin, D.[1], Lockie, R.G.[1,3], Dawes, J.J.[1,4,5], Simas, V.[1], Canetti, E.F.D.[1,6], Schram, B.[1,6] & Orr, R.M.[1,6]

[1]Tactical Research Unit, Bond University, QLD, Australia; [2]School of Behavioural and Health Sciences, Australian Catholic University, QLD, Australia; [3]Department of Kinesiology, California State University, California, United States; [4]School of Kinesiology, Applied Health and Recreation, Oklahoma State University, Oklahoma, United States; [5]OSU Tactical Fitness and Nutrition Lab, Oklahoma State University, Oklahoma, United States; [6]Faculty of Health Science and Medicine, Bond University, QLD, Australia

PURPOSE: The 20 m Multistage Fitness Test (MSFT) and 2.4km run are common measures of aerobic fitness, with fitness testing playing a significant role in the academy training of law enforcement recruits. These tests may be interchanged throughout their training, and potentially their period of employment. Noting this, the respective strengths and weaknesses of each assessment can vary. Therefore, this study aimed to develop normative percentile rankings for the 20MSFT, and 2.4km run specific to law enforcement recruits; and to analyse the relationship between the two tests. **METHODS:** Data from five cohorts of law enforcement recruits completing 20MSFT (n=1536) and 2.4km run (n=1499) testing during basic training at an Australian Police Academy were retrospectively analyzed. Percentile ranks were calculated (20th, 40th, 50th, 60th, 80th, and 99th) based on the number of shuttles completed and time (seconds) to complete the 2.4km run. Results were split by sex and age (i.e., <20 years, 20-29 years, 30-39 years, and 40-49 years). A linear regression analysed the relationship between the 20MSFT to the 2.4km run (using both seconds and km.h^{-1}), producing predictive equations to translate scores between the two assessments. **RESULTS:** These data presented the first detailed normative values distributed by age and sex for Australian law enforcement recruits (Table 1). Further, the results demonstrated regression models could explain 65%-74% of the variance observed (r^2 = 0.649 – 0.741) between 20MSFT performance and 2.4km run performance. **RELEVANCE:** This studies' findings allow for a) normative fitness performance to be examined for the purpose of benchmarking fitness, b) comparisons in rankings between the two most implemented tests, c) setting performance goals for personnel, and d) rehabilitation from injury. Additionally, the moderate level of certainty provided through this linear regression conversion affords cross-agency comparisons, and allowances for temporary changes in test selection.

Table 1: Summary of Recruit Fitness Data.

Overall Recruit Fitness Summary	20MSFT	2.4-km Run
Median (50%ile), Male:Female	Level 9-2 : Level 7-6	10:55 : 12:33
Mean, Male:Female	Level 9-3 : Level 7-10	10:58 : 12:27
2SD below mean, Male:Female	Level 5-9 : Level 5-7	13:20 : 14:52
< 20 years age group	**20MSFT**	**2.4-km Run**
Range, Male	62.00 (8-1) – 116.0 (12-8)	14:31 – 9:32
Range, Female	53.00 (7-2) – 78.00 (9-5)	13:33 – 10:35
20 – 29 years age group	**20MSFT**	**2.4-km Run**
Range, Male	62.00 (8-1) – 121.0 (13-1)	11:52 – 8:33
Range, Female	53.00 (7-2) – 98.00 (11-2)	13:30 – 10:05
30 – 39 years age group	**20MSFT**	**2.4-km Run**
Range, Male	58.00 (7-7) – 123.0 (13-3)	12:10 – 8:39
Range, Female	52.00 (7-1) – 100.0 (11-4)	12:58 – 9:22
> 40 years age group	**20MSFT**	**2.4-km Run**
Range, Male	53.00 (7-2) – 102.0 (11-6)	12:00 – 9:18
Range, Female	53.00 (7-2) – 109.0 (12-1)	14:09 – 9:26

Key: Overall data is test level completed for 20MSFT and minutes:seconds for 2.4km run. Age-group data is presented as range between the 20th-99th percentiles, with 20MSFT data shown as total shuttles completed (test level).

THE INCIDENCE AND RISK FACTORS FOR THE DEVELOPMENT OF STRESS FRACTURES IN MILITARY RECRUITS AND QUALIFIED PERSONNEL: A RAPID REVIEW

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PURPOSE: Stress fractures are a considerable burden to military organisations. Despite the large volume of evidence regarding incidence rates and risk factors for stress fractures, a comprehensive synthesis of high-quality academic evidence is lacking. This aim of this review was to identify and synthesise findings from studies reporting on the incidence of, and risk factors for, stress fractures in military personnel. **METHODS:** The Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines were followed. The study protocol was registered with the Open Science Framework, and three academic databases were searched using considered terms. Key findings from included studies were extracted, including risk factors, incidence, and risk ratios (e.g., relative risk, hazard ratios, and incidence rate ratios). The Joanna Briggs Institute critical appraisal toolkits were used to assess the methodological quality of eligible studies. **RESULTS:** Sixty-five articles were included, with an average methodological quality score of 78%. The incidence of stress fractures in military recruit/trainee populations (13.7–1,713 stress fractures per 1,000 person-years) was substantially higher than qualified personnel (2.7–56.9 stress fractures per 1,000 person-years). Stress fractures predominantly occurred in the tibia, fibula, and metatarsal bones. Specific sub-populations at risk included older military recruits/trainees (and qualified personnel), and female recruits and service members. Risk factors in recruits/trainees included: consumption of >10 alcoholic drinks per/week, underweight BMI, entering basic training without a prior history of exercise undertaken at least 3 times/week or for a total of at least 7 hours per week in the previous 12-months, low serum 25(OH)D (liver metabolised vitamin D_3) levels, prior intake of non-steroidal anti-inflammatory drugs, and initial stages of military training/physical training with the highest volumes of overall loading. **RELEVANCE:** The findings highlight the incidence of stress fractures in both recruit and qualified military personnel and identify a range of risk factors in military environments.

A PROFILE OF OCCUPATIONAL TASKS PERFORMED BY MOUNTED POLICE OFFICERS

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PURPOSE: Within individual policing organisations, there are a wide variety of units and job roles. The aim of this study was to profile the occupational tasks performed by Australian mounted police officers to offer insight into this unique job role. **METHODS:** Thirteen fully qualified and operational mounted police officers (n=11 females), who served in the mounted police unit for ~3.3 (± 2.3) years, participated in this observational cohort study. Participants filled out a survey to outline common occupational tasks and were followed by the researchers throughout four consecutive shifts who logged the participants' body position, physical activity undertaken, task effort, and load carriage. Participants were also fitted with a physiological monitoring device (Equivital EQ-02,

Hidalgo, UK) recording continuous data on heart rate (HR), respiratory rate (RR), and skin temperature (ST). A one-way ANOVA was used to assess mean differences in these physiological measures between the three most reported tasks. **RESULTS:** The three most reported mounted police tasks were: ‘horse riding’ (n=13, 34%), ‘mounted patrols’ (n= 8, 21%), and ‘horse care’ (n=8, 22%). Similarly, the three most physically demanding mounted police tasks were: ‘horse riding’ (n= 14, 44%), ‘mounted patrols’ (n= 7, 19.4%) and ‘horse care’ (n= 7, 19.4%). On average, officers spent less time caring for the horse than riding (↓57±17min less, p=0.008) or in mounted patrols (↓101±17min, p<0.001) (Table 1). HR during horse care and horse riding were significantly higher than when patrolling (↑27±7bpm, p=0.001 and ↑33±8bpm; p=0.001, respectively). Mean RR was higher whilst riding the horse when compared to horse care (↑5.3±1.6brpm) and patrol (↑8.5±1.9brpm). **RELEVANCE:** This study provides an unprecedented profile of specific job tasks and occupational stressors imposed on mounted police. This information may assist in the development of occupation-specific fitness assessments, and guide appropriate rehabilitation and return to work protocols for injured mounted police officers.

Table 1: Differences in physiological demand between three most reported tasks.

Task	**Duration (Minutes)**	**HR (Beats/Minute)**	**RR (Breaths/minute)**	**ST (°Celsius)**
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Horse care (n= 14)	19.5 ± 10.3*, ʬ	114.6 ± 9.5*	25.8 ±2.9*, ʬ	35.7 ± 0.6
Riding horse (n= 7)	76.1 ± 64.1 ʬ	120 ± 20.5ǂ	31.1 ±5.5 ǂ, ʬ	35.8 ± 1.1
Mounted patrol (n= 7)	120 ± 35.2*	87.4 ± 16.5*, ǂ	22.6 ± 2.2*, ǂ	35.9 ± 0.7

*Significant differences between ‘horse care’ and ‘mounted patrol’ p < 0.05; ǂSignificant differences between ‘riding horse’ and ‘mounted patrol’, p < 0.05; ʬ Significant differences between ‘horse care’ and ‘riding horse’, p < 0.05.

MANUAL HANDLING TASK DEMANDS ACROSS THE ROYAL AUSTRALIAN AIR FORCE

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PURPOSE: The purpose of this investigation was to characterise the physical demands of manual handling tasks within the Royal Australian Air Force (RAAF). This information can inform physical conditioning programs and physical employment standards. **METHODS:** Job task analysis were performed for 27 RAAF trades. Criterion tasks were identified through a systematic approach involving workshops and field-based data collection with trade personnel. The identified manual handling tasks were then assessed for the dominant physical capacity and grouped into movement-based clusters determined by the characteristics of tasks, such as movement actions and working postures. Data are presented as median (interquartile range). **RESULTS:** Of 87 criterion tasks identified, 80 (92%) were characterised as manual handling dominant, requiring the principal physical fitness attributes of muscular strength (51 tasks [59%]), muscular endurance (45 tasks [52%]), cardiorespiratory endurance (34 tasks [39%]), and high-intensity activity (2 tasks [2%]). The most common movement clusters were *Lift to Platform* (38 tasks [44%]) and *Lift and Carry* (33 tasks [(38%]). All *Lift to Platform* tasks required lifting from the ground to a median height of 1.32 m (1.20–1.65 m) and handling a median mass of 25.0 kg (21.0 – 28.9 kg) per person. Single person lifts (63%) and single discrete lifts (53%) were the most common lifts performed. Median carry mass was 25.0 kg (22.4 – 36.1 kg) per person and carry distance was 26.0 m (17.5 – 50.0 m). The majority (61%) of carries were two handed. **RELEVANCE:** The results highlight the prevalence of manual handling tasks for RAAF personnel, and by extension, the importance of muscular strength and muscular endurance. Characterisation of occupational physical task demands permits the development physical standards, setting of defensible cut-scores and providing a foci for physical conditioning programs, thus ultimately improving the alignment with workforce capability and occupational demands.

CARDIORESPIRATORY ENDURANCE TASK DEMANDS ACROSS THE ROYAL AUSTRALIAN AIR FORCE

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PURPOSE: The purpose of this investigation was to characterise the cardiorespiratory demands of tasks performed by Royal Australian Air Force (RAAF) personnel to inform physical conditioning programs and physical employment standards (PES). **METHODS:** Job task analysis were performed for 27 RAAF trades. Criterion tasks were identified thorough a systematic approach involving workshops and field-based data collection with trade personnel. Task mean oxygen consumption (VO_2), heart rate (HR), and rating of perceived exertion (RPE; Borg 6–20 scale) were collected from RAAF personnel performing occupational tasks or simulations thereof. Manual handling information was also collected. Criterion tasks were then assessed for dominant physical capacity. Data are presented as inter-individual median (interquartile range). **RESULTS:** Of 87 criterion tasks identified, cardiorespiratory endurance was deemed a dominant physical capacity in 34 tasks (39%). Cardiorespiratory demands were measured for 31 of these tasks, involving 220 personnel across 17 trades. Median task mean VO_2, HR and RPE were 1.8 $L.min^{-1}$ (1.5–2.2 $L.min^{-1}$), 137 beats/minute^{-1} (120–144) and 13 (12–14), respectively, with a duration of 9:12 min:sec (7:30–24:36). Twenty tasks (65%) elicited a mean VO_2 of between 1.5–2.5 $L.min^{-1}$, while 14 tasks (45%) also involved repeated manual handling (i.e., tasks involving multiple lifts/carries); the number of items handled was 11 (5–24) and carry distance was 20 m (10–32), with all 14 tasks involving handling items ≥22.0 kg. **RELEVANCE:** Although the movement

patterns and task characteristics varied across the 31 tasks, they tended to have a moderate cardiorespiratory demand. The findings also highlight the ubiquitous nature of manual handling, with RAAF personnel thus requiring substantial whole-body muscular endurance and strength. Finally, the results suggest the potential of a limited suite of PES assessments, potentially with scalable standards, to assess the physical capacity of its workforce in a valid, reliable, and efficient manner.

TIME-MOTION ANALYSIS OF NEUTRAL-BUOYANCY LAB RUNS TO SIMULATE MICRO-GRAVITY EXTRA-VEHICULAR ACTIVITIES

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PURPOSE: The aim of this study was to characterise the movement patterns of astronauts as they complete Neutral-Buoyancy Laboratory (NBL) runs simulating micro-gravity extra-vehicular activities (EVAs). A comprehensive description of the movement patterns during NBL runs allows the development of highly effective preparatory training programmes and to develop specific physiological tests to examine astronauts' preparedness for EVAs. **METHODS:** Three Canadian astronauts (anthropometrics not shared to maintain anonymity) had their movements during 14 NBL runs analysed by video-based time motion analysis. Movements were classified as passive (no movements) or active (Fine-motor, Gross-Motor, Other). Fine-motor movements are characterized by the wrist/hand being the main joints solicited during the action; Gross-motor movements are characterized by the shoulder/elbow being the main joints solicited during the action; Other movements were any other movements not previously defined. Movement patterns and metabolic cost (obtained from CO_2 measurements from the ombilical and via Peronnet transformation) were analysed on a 1-sec interval for the task-oriented duration of the runs. **RESULTS:** Mean (SD) NBL run duration was 04:50:49 (01:04:05) hh:mm:ss with a metabolic cost of 0.914 (0.099) L O_2*min^1. Mean movement patterns observed and described during the video-based time motion analysis (Table 1). **RELEVANCE:** NBL micro-gravity runs are qualified as one of the most physically demanding tasks that Canadian Space Agency astronauts must perform. From the time motion analysis and given the effect of the pressurized suit/gloves to 4.3 PSI creating a rigid exterior shell, a high focus on upper-body metabolic endurance and muscular endurance is required during astronauts' physical training to meet the rigors of NBL runs.

Table 1: Mean (SD) movement patterns observed during the video-based time motion analysis.

	Passive		Active	
Duration (hh:mm:ss)	01:56:13 (00:33:49)		02:54:37 (00:30:15)	
Duration (%)	39.52 (8.38)		60.48 (8.38)	
		Fine-Motor	Gross-Motor	Other
Duration (hh:mm:ss)		00:34:28 (0024:32)	02:18:46 (00:30:05)	00:01:23 (00:01:14)
Duration (%)		19.34 (12.31)	79.85 (12.76)	0.81 (0.77)

PHYSICAL DEMANDS OF TRAINING TASK OF THE CANADIAN CLEARANCE DIVERS TO DEVELOP A SELECTION PHYSICAL FITNESS EVALUATION.

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PURPOSE: Clearance Divers (CL DVRs) are highly trained sailors who fulfil a variety of tasks including mine countermeasures in shallow waters, and Explosive Ordinance Disposal (EOD) in a bomb suit. The aim of this study was to assess the physical demands of training tasks for CL DVRs with the purpose of developing a selection Physical Fitness Evaluation. **METHODS:** Ten CL DVRs students [mean (SD) age: 26.9 (2.6) years, weight: 83.4 (10.0) kg, height: 181.7 (5.4) cm, estimated maximal aerobic capacity: 57.5 (2.8) mL O_2*kg^{-1}*min^{-1}, maximal strength: 2215 (260) N] participated in 78 shallow water dives, three diving casualty evacuation simulations and four EOD simulations in the bomb suit. Maximal aerobic capacity was estimated from a 2.4 km run, and maximal strength was assessed on the Isometric Mid-Thigh Pull. Metabolic cost was measured via ventilatory (VO2master, Canada) or estimated via heart rate (PolarH10, Finland) measurements. External loads were measured with force gauges (Chatillon DFS, USA) or scales. **RESULTS:** During the dives, the mean (SD) % heart rate reserve (HRR) was 52.9 (7.2) % with an estimated energy cost of approximately 0.243 kW. The maximum and minimum %HRR during the dives were 72.4% and 31.6% respectively. The peak (SD) pull loads required to evacuate a casualty diver out of the water into the safety boat was measured at 88 (7) kg. The estimated mean metabolic cost of the EOD simulation in the bomb suit was 21.4 (3.9) mL O_2*kg^{-1}*min^{-1}, and the peak values were 35.5 (5.5) mL O_2*kg^{-1}*min^{-1} during the lane clearance portion. The loads carried during the EOD simulation were 40 kg. **RELEVANCE:** The CL DVRs course is physically demanding therefore candidates are recommended to complete appropriate physical preparation to be successful on selection. From the physical demands obtained, a selection Physical Fitness Evaluation with performance objectives was developed.

EXPLORING RECRUITING OPPORTUNITIES - ADJUSTING PHYSICAL FITNESS STANDARDS FOR ARMY RECRUITS

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PURPOSE: The aim of this study was to compare physical fitness and completion rates of non-combat recruits commencing the Australian Army basic military training (BMT) program under alternate physical fitness standards. **METHODS:** Data was collected from September 2021 to August 2022, and the 12-week BMT program was consistent for all intakes over this period. Physical fitness, derived from the 20-m multi-stage shuttle run test (beep test), push-ups, and a box lift, was assessed at weeks 2 and 8 of BMT. BMT completion rates were also monitored. The recruits who enlisted under the pre-existing physical fitness standards (beep test: 7.5 level.shuttle, push-ups: 15♂/8♀) were defined as 'OLD', while recruits enlisting under lowered standards (beep test: 6.1 level.shuttle, push-ups: 8♂/4♀) were defined as 'NEW'. Two-way repeated measures ANOVAs were used to compare performance between groups (NEW, OLD) and across time (week 2 and 8) within sex. Chi-squared analysis assessed differences in completion rates. **RESULTS:** The NEW and OLD recruits had similar BMT completion rates of 85% and 86% respectively ($p>0.05$, $\chi = 0.0403$). Male recruits from both OLD and NEW improved ($p<0.05$) beep test, push-ups, and box lift from week 2 to 8 (Table 1). However, OLD males demonstrated greater performance ($p<0.05$) in beep test and push-ups compared with the NEW recruits. Female recruits from both groups improved ($p<0.05$) beep test and push-ups from week 2 to 8, while only NEW females improved ($p<0.05$) box lift performance over this time (Table 1). **RELEVANCE:** These preliminary findings indicate similar outcomes in recruits entering BMT under alternate physical fitness standards. The results provide early insight into potential strategies to mitigate the decreasing recruitment pool in the civilian population and associated recruiting pressures. Additional data including injury incidence and career progression beyond BMT are required to comprehensively evaluate the impact of adjusted entry standards.

Table 1: Summary of physical fitness changes during BMT between groups

Measure	Group	Week 2	Week 8	Mean change
Predicted VO_{2max} ($mL.kg^{-1}.min^{-1}$)	OLD Male(n=228) # ^	43.5 ± 5.0 a	48.3 ± 4.5 a *	4.8 (4.3:5.3)
	NEW Male (n=127) # ^	37.6 ± 4.6	43.5 ± 4.6 *	5.8 (5.2:6.5)
	OLD Female(n=29) # ^	38.2 ± 4.0 a	42.7 ± 4.2 a *	4.5 (3.1:6.0)
	NEW Female (n=58) # ^	34.6 ± 3.5	39.8 ± 4.5 *	5.2 (4.1:6.3)
Push-ups (repetitions)	OLD Male(n=240) ^ #	36 ± 13 a	44 ± 11 a *	8.5 (7.5:9.5)
	NEW Male (n=133) ^ #	27 ± 11	37 ± 11 *	9.6 (8.6:10.6)
	OLD Female(n=32) # ^	20 ± 10 a	27 ± 8 *	6.6 (3.7:9.4)
	NEW Female (n=63) # ^	12 ± 8	22 ± 8 *	9.7 (7.9:11.4)
Box lift (kg)	OLD Male(n=215) # ^	46.7 ± 5.5 a	48.7 ± 3.3 *	2.0 (1.3:2.7)
	NEW Male (n=117) # ^	45.3 ± 5.6	47.9 ± 4.0 *	2.6 (1.6:3.6)
	OLD Female(n=27) ^	38.8 ± 7.2	40.9 ± 6.1	2.1 (-1.1:5.3)
	NEW Female (n=58) ^	36.2 ± 8.2	41.0 ± 7.6 *	4.8 (2.4:7.3)

*Data are mean ± standard deviation, mean change data are mean (lower:upper 95% confidence intervals), ^ denotes a significant main effect ($p<0.05$) for time (within sex), # denotes a significant main effect ($p<0.05$) for group (within sex), * denotes a significant change ($p<0.05$) from baseline, a denotes a significant difference ($p<0.05$) compared with NEW (within sex).

THE BENEFITS OF A MODULAR PHYSICAL EMPLOYMENT STANDARDS APPROACH: MODIFICATIONS TO ACCOMMODATE CHANGE IN AMMUNITION HANDLING JOB-TASKS

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PURPOSE: Physical employment standards (PES) ensure the physical demands of job-tasks match those assessed during fitness tests. In doing so, PES are legally defensible, mitigate injury, and increase personnel productivity. An important step in developing bona fide PES, is the comprehensive profiling of criterion job-tasks. When job-tasks change, the physical fitness tests must be adapted to meet the new demands. In 2019, the British Army implemented new PES for Ground Close Combat (GCC) roles. For the heavy armour role, PES was informed by the requirement to operate the in-service Challenger 2 Main Battle Tank (MBT). The introduction of the Challenger 3 MBT will see a change in main armament where the existing two-piece ammunition will be replaced by heavier and larger one-piece ammunition. The purpose of this study was to evaluate the impact of this change on point-of-entry and in-service GCC PES.

METHODS: Subject matter expert consultations identified changes in job role requirements were isolated to those manual handling tasks associated with the new one-piece ammunition (29.2kg & 21.5kg). Through an in-service evaluation of 18 personnel, loading and unloading task performance was observed, timed, and subjectively rated. **RESULTS:** Lifting of the new ammunition overhead and the increased carry mass were identified as the key role requirement changes. **RECOMMENDATIONS:** The following recommendations are under consideration: 1) replace the current GCC Representative Military Task (RMT) assessing manual handling (repeated lift & carry) with two separate RMTs (repeated carry, incremental lift) for in-service personnel, and 2) continue to use the same heavy armour point-of-entry-PES standards. **RELEVANCE:** In conclusion, a modular approach to the PES design may be well suited to roles with a large array of physical task requirements, in order that individual fitness tests may be inserted or updated in isolation without the need for a full test revalidation.

CONNECTING THE DOTS BETWEEN PHYSICAL DEMANDS, PHYSICAL EMPLOYMENT TESTING AND PHYSICAL FITNESS IN A PARAMEDICINE CONTEXT

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PURPOSE: The purpose of this panel discussion is to initiate a much-needed conversation regarding the physical demands, physical employment testing, and physical fitness for the paramedic role in Australia and internationally. **METHODS:** A panel discussion aimed at ‘connecting the dots’ will take a deep dive into previous and current research and practical work being conducted internationally and across Australian jurisdictional and non-jurisdictional ambulance services. Through four proposed speakers the following topics will be discussed: 1) Paramedic health and fitness; 2) physical demands of the role; 3) what is the impact; and 4) standards, testing, and implementation. **RELEVANCE:** Physical fitness, health, and the performance of physical tasks safely and efficiently are closely linked. For paramedics, Australia’s existing pre-employment physical fitness assessments are not standardised across jurisdiction and non-jurisdictional ambulance services and settings. These assessments frequently do not directly relate to the physical demands of the paramedic role and daily tasks performed. There is increasing evidence supportive of the need for standardised and requisite minimum levels of fitness; however, the development and establishment of the standards cannot be done without first determining the physical demands of essential tasks performed by Australian paramedics

through a comprehensive Physical Demands Analysis. Current registration requirements for paramedics, set by the regulatory agencies, include professional standards that appear vague regarding physical fitness, but note that maintenance of physical and mental health is required of paramedics. The significant rates of illness and injury in Australian paramedics indicate systematic analysis of the role and, on that basis, introduction of evidence-based pre-employment physical fitness assessment standards are needed. Physically prepared paramedics, along with validated physical fitness assessments and physical employment standards are vital to paramedic physical health, safety, and efficient provision of high-quality patient care and increased patient safety.

QUANTIFYING THE ESSENTIAL TASKS OF OFFSHORE WIND TECHNICIANS

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PURPOSE: Offshore wind technicians (WTs) have been identified as having an occupation with high physical demands. To assess WTs capability to undertake the job, there was a need to quantify the physical requirements of previously proposed essential tasks. **METHODS:** Wind Farm organisations (n=8) across five countries, undertook semi-structured interviews (n=59) and a questionnaire (n=167) to quantify, where possible, the most physically demanding tasks. Additionally, 14 WTs (n=13 male, 1 female) were monitored over three consecutive working days. The data collected consisted of a questionnaire, heart rate, movement (Polar, Team Pro), and accelerometer (GENEActiv) data. **RESULTS:** The physical requirements of the essential tasks are summarised in Table 1. A working day lasted 7.5 hours to 9 hours, with WTs covering, on average, 4.5km on the turbine. WTs spent 28% of their time undertaking "light activity", 69% "moderate activity" and 3 % working "vigorously". The greatest amount of time in a day was spent working on manual handling tasks such as torque and tensioning (up to 4 hours in total). These tasks involved moderate (~70% of the time) and low metabolic (~22% of the time) demands. **RELEVANCE:** The results presented constitute work carried out in Phases 1 and 2 of a three phased work stream, to establish the physical capacity required by WTs. These findings will constitute the minimum performance standards used to develop physical capacity tests. Such assessments of physical capacity are based upon the essential-frequent and essential-infrequent tasks undertaken by WTs. The assessments of physical capacity will ensure that WTs have, and maintain, a level of fitness that is sufficient to safely perform their job to at least a minimum acceptable standard.

Table 1: Tasks descriptions for offshore wind technicians.

Task	Task Description
Single person (SP) rescue	Perform a SP recue of a 101.9kg casualty from the Hub in a <6 mW turbine. Perform a SP rescue of a 95.9kg casualty up a tower.
Climb the turbine from TP to the Nacelle	Climb 120m (turbines ≥6 mW), whilst wearing normal PPE and full climbing equipment, at a minimum rate of 30 rungs.min^{-1}. On reaching the Nacelle have a maximum of 20 minutes rest before starting a task.
Climb a 20m ladder	Climb 20m, at a minimum rate of 30 rungs.min^{-1}, with the ability to lift the thigh past 90^0 whilst wearing a drysuit normal PPE and full climbing equipment.
Hydraulic torque and tensioning	Repeatedly lift the torque/tension head (10 kg) 10 times and attach to bolts spaced evenly from ground level to 150cm. Rest for 15 mins and repeat. Wearing normal PPE.
Lifting and carrying	To be able to lift a container, with a mass of 20kg, and walk 6m. Then lift it up onto a table (~76cm). Wearing normal PPE.
Maneuvering into tight spaces	Access and egress from various areas of the turbine e.g. Gearbox (dimensions H x W x L 39cm x 60cm x 200cm); Hatch (diameter of 59cm and length 50cm); Generator are (diameter of 59cm, drop of 60cm)

PROTOCOL FOR IDENTIFYING AND CHARACTERISING CRITICAL PHYSICAL TASKS IN THE SWEDISH ARMED FORCES

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PURPOSE: When establishing physical employment standards, validity is dependent upon correct identification and characterisation of critical job tasks. The objective of this study was to develop and validate a standardised protocol for identifying, characterising, and documenting critical physical job tasks in the Swedish Armed Forces (SwAF) military occupational specialties (MOS). **METHODS:** Firstly, a protocol draft was developed with three content domains; documentation of the subject experts' expertise, task identification source, and task characteristics. Thereafter, protocol content validity was iteratively assessed in two consecutive stages where 10 subject experts (SwAF personnel and researchers) rated relevance and simplicity on a four-point Likert scale. After each stage, a consensus panel (SwAF personnel and researchers) revised the protocol. Content validity index (CVI) was calculated per item (I-CVI) as the proportion of experts rating it as relevant and simple, and as a scale average (S-CVI/Ave) across items of the entire protocol. The thresholds for acceptable content validity were 0.78 and 0.90, respectively. Lastly the protocol was language reviewed, reorganised for easy use, and approved by the consensus panel. **RESULTS:** The validated protocol consisted of 35 items with an I-CVI ≥ 0.90 and ≥ 0.80 for relevance and simplicity, respectively. The entire protocol showed

a S-CVI/Ave of 0.97 for relevance and 0.98 for simplicity. The final protocol included: background and aim of the protocol, definitions of critical physical job tasks, protocol instructions and 63 items covering the three content domains. **RELEVANCE:** This standardised protocol for identification and characterisation of critical job tasks in SwAF MOS was developed and validated with the target population. The subject experts rated its content relevant and simple. As such, this protocol will add to the future work with establishing physical employment standards in the SwAF by ensuring traceability of information sources used for the identification and characterisation of critical job tasks.

ASSOCIATIONS BETWEEN SOLDIERS PHYSICAL FITNESS AND OCCUPATIONAL TASK COURSE PERFORMANCE

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PURPOSE: In military operations, various combat tasks (e.g., sprints, load carriage, etc.) are performed in a repeated manner and with inadequate recovery time between tasks. Previous studies have reported fitness predictors for a military simulation or individual tasks performed only in a recovered state. Therefore, the purpose of this study was to describe associations from two simulated military task performance tests: one in recovered state and another with repeated measures reflecting unrecovered state. **METHODS:** Two different military simulation task courses were compared (Table 1.)

Table 1. Descriptions of included studies by Pihlainen et al. (2018) and Ojanen et al. (2023)

Task	Pihlainen et al. 2018 s	Ojanen et al. 2023
Rushes	5 + 5 + 5 + 5 m	-
Running	20 + 20 + 40 + 45 m	10 m + 10 m
Low Crawl	10 m	10 m
Jumping	3 obstacles (40 cm)	-
Carrying	5 + 5 + 5 + 5 m (2 x 16 kg)	10 m + 10 m (2 x 16 kg)
Dragging	20m (65 kg)	10 m (75 kg)
	Course Details	
Total distance	242 m	60 m
Number of intervals	1	3
Rest periods	none	1 min
Time	144 ± 22 s	36.0 ± 5.6 s
		44.0 ± 8.7 s
		49.6 ± 12.1 s

References: Pihlainen, K., Santtila, M., Häkkinen, K., & Kyröläinen, H. (2018). Associations of Physical Fitness and Body Composition Characteristics with Simulated Military Task Performance. Journal of strength and conditioning research, 32(4), 1089–1098. Ojanen, T., Pihlainen, K., Vaara, JP, Kyröläinen, H. (2023). Performance changes during repeated military occupational test and its associations to physical performance. Accepted 26.12.2022. Ergonomics

RESULTS: Pihlainen et al. (2018) reported that the countermovement jump (CMJ) performed with the combat load (19.5±1kg) correlated (r=-0.66, p<0.001) most with performance time in military stimulation test (MST) in a recovered state. The best predictors for the MST performance were dead mass ratio, 3000m run, push-ups and countermovement jump. Ojanen et al. (2023) found that during repeatedly performed high-intensity MST, CMJ, lower body power, and upper body strength were the best predictors for the MST performance in the first run (r=-0.55 – -0.66, p>0.05), but in the second and third runs, aerobic endurance (3.2km loaded march) replaced lower body power (r=0.58, p=0.05). **RELEVANCE:** In the battlefield, soldiers are required to perform occupational tasks continuously for long time periods, but some high-intensity tasks may occur also in a repeated manner with short recovery times. The findings of the present studies emphasize the importance of lower body power, dead mass ratio and skeletal muscle mass as well as aerobic fitness. In addition, anaerobic and aerobic fitness becomes even more important in repeated military occupational tasks, especially with high intensity workload. The present findings suggest that nature of reference tests, whether done in recovered or unrecovered state are of high importance when they are used for basis of training prescription.

LOWER-BODY MUSCULAR POWER PREDICTS PERFORMANCE ON URBAN COMBAT SIMULATION

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PURPOSE: Military operations in urban environments requires faster movements and induces a higher cardiovascular strain than traditional operations. It also places greater demands on soldier strength and anaerobic ability. The aim of this study was to develop an occupationally relevant test for urban combat soldiers and investigate how a 5-day military field exercise (MFE) affects the associations between physical performance and performance in the new occupational test. **METHODS:** Twenty-six conscripts (mean age = 20±1 years; mean height = 181±6cm; mean weight = 73.6±6.3kg; Body Mass Index (BMI) = 22.8±2.1kg/m^2) volunteered to participate in the study. Occupational performance was determined by using the newly developed Urban Jaeger Test (UJT); which included a 50m sprint, moving a truck tire (56kg) 2m with a sledgehammer, a kettlebell carry (2x20kg) 21 steps up on stairs, sandbag lifting (20kg) four times and a 20m-mannequin (85kg) drag. Physical performance tests included measures for endurance, dynamic muscle endurance, explosive force production, anaerobic capacity, and maximal isometric strength. Spearman correlation and linear regression analyses were performed with IBM SPSS Statistics 25 (Armonk, NY: IBM Corp). **RESULTS:** UJT performance before and after the MFE correlated with upper and lower body maximal strength (r = -0.59 to -0.78, p≤0.05). Anaerobic power and capacity correlated with UJT times for the evacuation component (r = -0.58 to -0.74, p≤0.05). In the regression analyses, fat free mass (r^2 = 0.50, p≤0.01) and counter movement jump in combat load (r^2 = 0.46, p ≤ 0.01) most strongly explained UJT performance. The relationship between the abovementioned variables and UJT performance strengthened after the 5-day MFE. **RELEVANCE:** This study demonstrated that urban combat soldiers require significant amounts of muscle mass and greater lower body explosive force production together with upper body maximal strength. After a 5-day MFE the associations for UJT and anaerobic power and capacity increased, emphasizing the role of periodized physical training.

A COMPARISON OF TWO LAW ENFORCEMENT MARKSMANSHIP ASSESSMENTS

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PURPOSE: Law enforcement officers are typically required to pass an annual marksmanship assessment to continue patrol duties. These annual assessments may not reflect on officer perceptions of confidence and handling of their firearm. The aim of this study was to identify differences in success rates and officer perceptions in firearm confidence and handling between a current Traditional Pistol Assessment (TPA) and a Proposed Pistol Assessment (PPA). **METHODS:** A prospective, within-subjects, randomised, repeated measures study design was used. Officers (male n=8; female n=6; length of service 5.8±4.8 years) from an Australian law enforcement agency participated in the TPA or PPA in randomised order (group randomisation). The TPA and PPA were composed of seven (n=24 rounds) and six (n=16 rounds) serials, respectively. The TPA was a static marksmanship assessment while the PPA included serials mimicking real-world scenarios (e.g., moving backward while shooting, shooting from behind a barrier, etc.). Officers completed a survey pre- and post-assessments rating how comfortable, confident, and safe they felt handling and firing their firearm. Scores ranged from zero (signifying not safe, comfortable, or confident) to 10 (signifying extremely safe, comfortable, or confident). Descriptive and inferential statistics (McNemar test, Chi-Squared, Fisher's exact test, and a Wilcoxon Signed Rank Test) were performed (alpha < 0.01 to mitigate familywise error). **RESULTS:** Four (29%) officers passed the TPA, while seven (50%) passed the PPA. While the Wilcoxon Signed Rank test found no significant differences between the pre-post TPA survey scores, significant pre-post PPA improvements across all survey domains were identified (Table 1). **RELEVANCE**: More officers passed the PPA assessment than the TPA. Officer weapon handling confidence was also found to be greater following the PPA assessment. When employing a marksmanship assessment an organisation should consider 1) situational requirements of weapon employment, and 2) second order effects (like confidence in weapon handling).

Table 1: Wilcoxon Signed Rank Test Results comparing survey results pre and post TPA and PPA.

Variable	Comparison	P-Value	R
	Pre vs Post TPA	0.83	-0.33
Handling Comfort	Pre vs Post PPA	0.003	-0.57
	Post TPA vs Post PPA	0.014	-0.46
	Pre vs Post TPA	0.52	-0.37
Handling Confidence	Pre vs Post PPA	0.002	-0.6
	Post TPA vs Post PPA	0.14	-0.46
	Pre vs Post TPA	0.102	-0.31
Handling Safety	Pre vs Post PPA	0.015	-0.46
	Post TPA vs Post PPA	0.034	-0.4
	Pre vs Post TPA	0.096	-0.32
Firing Comfort	Pre vs Post PPA	0.004	-0.54
	Post TPA vs Post PPA	0.009	-0.49
	Pre vs Post TPA	0.202	-0.24
Firing Confidence	Pre vs Post PPA	0.002	-0.59
	Post TPA vs Post PPA	0.01	-0.48
	Pre vs Post TPA	0.408	-0.16
Firing Safety	Pre vs Post PPA	0.008	-0.5
	Post TPA vs Post PPA	0.071	-0.34

PERFORMANCE VARIATIONS BETWEEN THREE DIFFERENT BACKPACK SYSTEMS: A PILOT STUDY

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PURPOSE: Military personnel carry heavy backpack loads as part of their duty requirements. Different types of backpacks are worn due to preference, organisational suppliers, and/or mission requirements. The aim of this study was to compare physical performance while wearing three different backpacks, loaded with the same mission load. **METHODS:** Six (n=6: female n=1) ex-military and ex-specialist law enforcement personnel (body mass mean= 89.22kg, range=56-126kg) wore Spectre body armour with 2 x 3.79kg Armor Australia plates in addition to one of three backpack variants allocated in randomised counterbalanced design. Backpacks were loaded with military stores (e.g., military fatigues, water bottles with cups canteen, sleeping bags, individual shelter, etc.) totaling mean loads of 32.33kg, 32.10kg, and 32.75kg for backpack variant 1,2,3, respectively. Outcome measures were oxygen consumption (VO_2) during a 10 min weight

load walk at 5.5km/h, grip strength (for signs of brachial compression), time to complete a 5m rolling maximal sprint, and a 10m maximal victim drag with an 80kg mannequin. Participants were allowed 10 minutes rest between trials. A repeated measures ANOVA was conducted (alpha levels set at 0.05 a priori) to evaluate differences between pack variants. **RESULTS:** There were no statistical differences in physiological and physical performance measures between pack variants (Table 1). Some emerging trends in heart rate and hand grip strength may reach significance with larger sample sizes where variation is reduced. These may be of operational relevance. **RELEVANCE:** The weight of mission load and load distribution may be a more important factor than the type of backpack when performing general physical tasks that are of a short duration (<10 mins) in nature. Physical comfort levels and subjective perceptions may inform comfort and injury risk potential.

Table 1: Descriptive results of performance outcome measures.

Measure	Variant 1	Variant 2	Variant 3	p-value
Walk HR avg (bpm)	122.50±27.73	127.17±24.98	122.17±21.06	0.507
Walk HR max (bpm)	130.67±28.72	137.00±24.75	132.33±24.75	0.774
Walk VO_2 avg (mL/kg/min)	16.88±4.87	17.18±3.81	17.13±3.09	0.442
Walk VO_2 max (mL/kg/min)	22.90±8.28	21.77±5.13	21.55±3.79	0.075
GS R (kg)	38.33±10.21	40.83±8.23	39.50±9.46	0.456
GS L (kg)	39.50±13.23	39.33±10.84	42.00±11.03	0.594
5m Sprint (s)	1.35±0.17	1.31±0.20	1.34±0.16	0.785
10m Drag (s)	6.67±1.24	6.36±0.94	6.85±1.20	0.856

Data displayed as means and standard deviations. HR = Heart rate; VO_2=Volume of Oxygen; GS=grip strength; bmp=beats per minute; kg=kilograms' mL=milliliters; min=minutes; m=meters; s=seconds

VENTILATORY AND RESPIRATORY MUSCLE FUNCTION OF BRITISH ARMY INFANTRY SOLDIERS IS SIMILAR TO PHYSICALLY ACTIVE CIVILIANS AT REST AND IN RESPONSE TO TORSO-BORNE THORACIC LOAD CARRIAGE ACTIVITIES

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PURPOSE: This study sought to compare ventilatory and respiratory muscle function between infantry soldiers with load carriage (LC) experience and physically active civilians with no LC experience at rest and in response to LC activities. **METHODS:** Seventeen male British Army infantry soldiers and 14 physically active male civilians (Table 1) completed two trials on separate days (unloaded and donning 25kg). Each trial involved a treadmill 50-minute march ($4.8km \cdot h^{-1}$,

0% incline) followed by a 2km best effort test. Spirometry and respiratory muscle strength (maximal mouth pressures) were recorded at rest and in response to the march and best effort in both trials. Independent t-tests determined any differences at rest (unloaded), in spirometry and respiratory muscle strength, between the two groups. Three-way mixed-model ANOVAs determined any main effects and interactions with time point (rest, post march and post 2km), group (soldiers and civilian) and condition (unloaded and 25kg) with respiratory muscle strength. Alpha was set at $p \leq 0.05$. **RESULTS:** Resting spirometry and respiratory muscle strength values were similar ($p = 0.322 – 0.658$) between the two groups (Table 1). Significant reductions in maximal expiratory mouth pressure were observed in response to 25kg LC ($p = 0.036$) when compared to unloaded and with time ($p<0.001$), but no significant differences between groups or interactions were detected ($p = 0.441 - 0.724$). **RELEVANCE:** Prior LC experience does not provide any further advantage to ventilatory and respiratory muscle function at rest or following LC activities, than being physically active. LC activities can cause impairments to ventilatory and respiratory muscle function, which past studies have shown can impact physical performance. Respiratory muscle training (RMT) has been shown to ameliorate these impairments and improve LC performance in civilians. As both groups exhibited similar respiratory muscle function, RMT used in civilians may be transferrable to soldier populations.

Table 1: Descriptive Statistics, Ventilatory and Respiratory Muscle Function for Infantry Soldiers and Civilians.

Parameter	**Infantry Soldiers Mean (SD)**	**Civilians Mean (SD)**
n	17	14
Age (years)	23 (6)	22 (3)
Height (cm)	178.6 (5.87)	179.2 (7.90)
Mass (kg)	81.65 (10.36)	75.97 (11.77)
Years in service (years)	5 (5)	n/a
Forced vital capacity (FVC) (L)	5.34 (0.71)	5.57 (0.86)
Forced expired volume in first second (FEV_1) (L)	4.31 (4.31)	4.47 (0.76)
FEV_1/FVC	0.81 (0.06)	0.80 (0.07)
Peak inspiratory flow rate ($L \cdot sec^{-1}$)	9.01 (1.92)	9.42 (2.01)
Peak expiratory flow rate ($L \cdot sec^{-1}$)	10.04 (1.85)	10.65 (1.60)
Maximal inspiratory mouth pressure (cmH_2O)	136 (30)	130 (17)
Maximal expiratory mouth pressure (cmH_2O)	196 (34)	184 (50)

A NOVEL APPROACH TO CHARACTERIZING AND QUANTIFYING A SUSPECT APPREHENSION IN THE DEVELOPMENT OF A MODERNIZED PHYSICAL EMPLOYMENT STANDARD FOR A NATIONAL POLICE FORCE

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PURPOSE: Apprehending a non-compliant suspect is a public safety frontline policing task. While an officer's ability to bring a suspect to a controllable position has been identified as an important component of successful apprehensions, identifying the minimum strength/power to effectively perform this task remains a challenge. This study therefore aimed to 1) determine the most frequent movements, techniques, and postures during suspect apprehensions, and 2) identify the minimum force required to pull an actively resistive suspect off-balance. **METHODS:** First, 91 officers apprehended a suspect in a standardized scenario developed by subject matter experts. Scenario recordings were analysed to determine the frequency and duration of movements, techniques, and postures. Spearman's correlation was used to evaluate the association between participant characteristics and apprehension time, including by category and component. Second, 55 male officers with similar physical characteristics as the documented suspect donned a harness and resisted pull forces at the wrist, mid-chest, and mid-back. Peak force and foot pressure was measured (off-balance = taking a step). **RESULTS:** The average apprehension lasted 7.6±3.2 sec and consisted of an unsuccessful armbar, a two-handed pull (control phase), a two-handed cross-body pull (transition phase), and a two-handed push to the ground (ground phase) (Table 1). Officer age, height, body mass, and experience were not associated with apprehension time (all $p>0.14$) or with the time spent performing movements and techniques, respectively (all $p>0.28$). Table 1 shows the relationships between characteristics and each category's components. The peak force required to pull the most likely suspect off-balance was greatest at the wrist (54.2±11.8kg), followed by the chest (44.2±11.3kg) and back (29.9±11.3kg), and greater at the chest compared to back (all $p<0.001$). **RELEVANCE:** Our novel findings provide evidence to improve the design and legal defensibility of the future generation of suspect apprehension evaluations within law enforcement PES.

Table 1: Participant characteristics and their intercorrelation with individual movement, technique, and posture durations observed during the suspect apprehension scenarios.

Variable	Apprehension Scenario		Off-Balance Force	
	Officers	***Actors****	***Officers***	***Force Staff*****
M/F (#)	74/17	12/0	51/0	5/1
Age (years)	37 (8)	42 (6)	41 (8)	36 (5)
Height (m)	1.79 (0.08)	1.78 (0.08)	1.79 (0.04)	1.77 (0.04)
Mass (kg)	90.3 (16.7)	85.9 (7.7)	88.2 (7.1)	79.8 (14.5)
Experience (years)	8.8 (5.3)	-	-	-

Scenario Analysis	Overall		Spearman's Correlation (r)			
	Time (s)	**% *n***	**Age**	**Height**	**Mass**	**Experience**
Movements						
2-hand pull	3.8 ± 2.8	97	0.07	-0.08	-0.004	-0.03
2-hand cross-body pull	2.5 ± 0.7	68	0.02	0.13	0.17	0.02
1-hand pull	1.6 ± 1.0	24	0.19	-0.26§	-0.28§	0.16
2-hand push	2.6 ± 1.1	19	-0.04	-0.04	-0.08	-0.01
1-leg trip	1.2 ± 0.7	24	-0.21	0.01	0.07	-0.10
Techniques						
Armbar	2.5 ± 0.6	55	0.05	0.10	0.09	0.05
Wrist lock	4.1 ± 2.4	10	0.09	0.15	-0.05	-0.003
Push/pull to ground	3.1 ± 0.9	10	-0.15	-0.003	-0.06	-0.02
Spray	3.0 ± 0.0	7	0.27§	-0.29§	-0.13	0.13
Body Postures						
Upright	3.9 ± 3.3	99	0.24§	-0.14	-0.22§	0.18
Squat	2.7 ± 2.1	75	-0.07	0.12	0.15	-0.17
Kneel	1.3 ± 0.6	58	-0.10	-0.04	-0.05	-0.09
Bent	1.9 ± 0.8	45	-0.06	0.19	0.23§	-0.01
Mount	1.7 ± 1.0	6	-0.07	0.01	0.15	-0.05
Prone	1 ± 0.0	1	-0.16	-0.11	-0.16	0.04

Notes: **Use of force instructors acted as the most likely suspect to resist arrest. **Force staff represents the characteristics of those who applied the pulling forces. %n = Percentage of suspect apprehension scenarios where each movement, technique, or posture was observed. § = p<0*

ESTABLISHING A MINIMUM DISTANCE STANDARD FOR A MEDICINE BALL PROXY TEST BASED ON A SUSPECT APPREHENSION TASK SIMULATION WITHIN A NEW POLICE PHYSICAL EMPLOYMENT STANDARD: A PRELIMINARY ANALYSIS

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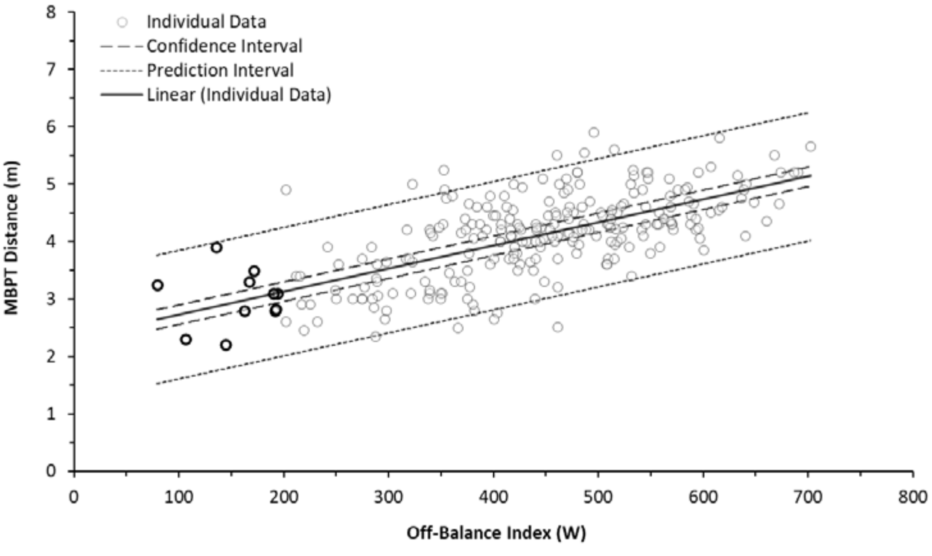
PURPOSE: Implementing physical employment standards (PES) across large national police agencies can be challenging, especially when administering task simulations requires extensive resources. Developing proxy tests can make regular assessments more cost-effective and practical. This preliminary analysis aimed to determine the viability of establishing a minimum distance standard for a seated medicine ball proxy test (MBPT) based on a suspect apprehension task simulation within a new national police PES. **METHODS:** To date, 252 police officers (197 males; 55 females; age: 39±8 years; height: 1.77±0.09 m; body mass: 86±16kg) have performed a suspect apprehension task simulation, which involved pulling a manikin off-balance and to the ground (calibrated to 54kg/force at a pull angle of 90°). The time required to pull the manikin off-balance (0.87m) was determined using the Kinovea video analysis software (5-trials) and normalized to the calibration work requirement of 461 J (off-balance index, W), after which its relationship to MBPT distance (3-trials) was examined using linear regression. Since all officers were successful on the task simulation (unlimited attempts/no rest), outliers within the predictor variable were identified using the mean absolute deviation (MAD) and the average used to predict a minimum MBPT distance. **PRELIMINARY RESULTS:** Linear regression established that the off-balance index predicted MBPT distance and accounted for 44.1% of the explained variability ($p<.001$, Figure 1). The average off-balance index for outliers (12 females; age: 40±10 years; height: 1.63±0.07m; body mass: 69±10kg) was 161±38 W, lower than 450±110 W for the remaining sample ($p<0.001$). This predicted a mean MBPT distance of 2.97 m (95% CI/PI, 2.80-3.14/1.85-4.09m). **RELEVANCE:** Our preliminary findings suggest that a suspect apprehension task simulation may be used to establish a minimum distance standard for a MBPT, notwithstanding the need for a representative sample of the workforce and further analysis considering force/power relationships.

Figure 1. Relationship between the off-balance index derived from the suspect apprehension task simulation and MBPT distance. The data points in bold represent the outliers identified within the predictor variable using the median absolute deviation.



A JOB TASK ANALYSIS OF THE AUTHORISED FIREARMS OFFICER – COUNTER TERRORISM NATIONAL ROLE PROFILE

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PURPOSE: The Ministry of Defence Police recognised the requirement to develop a Physical Employment Standard (PES) for the Authorised Firearms Officer – Counter Terrorism (AFO-CT) role profile. The purpose of this study was to conduct a job task analysis to identify the most critical and physically demanding tasks performed by AFO-CT personnel. **METHODS:** A focus group and online survey were undertaken to identify a list of job tasks. The down-selected job tasks were subsequently objectively monitored during training events to determine the most physically demanding tasks. Tasks were ranked by physical demand (heart rate monitoring and accelerometry) and additional factors (e.g., operational load). **RESULTS:** The focus group (n = 11; 23±9 years of Police service) identified 13 physically demanding and critical role-related tasks (Figure 1). The subsequent survey (n = 907; 11±11 years of police service) down-selected eight tasks with a 'moderate' demand or greater, removing five tasks from the process. Thirty (mean age = 34±9 years) AFO-CT personnel completed the remaining eight down-selected tasks as part of routine training events. From the observed tasks, four tasks were down selected and subsequently combined into two operationally relevant, reasonable worst-case standardised scenarios during a subject matter expert workshop (n = 5; 26±6 years of Armed Police experience). The two scenarios, 'Conduct Armed Search in the Open for an Active Shooter' and 'Casualty Drag' were used in subsequent phases of the research to form the basis of the AFO-CT PES. **RELEVANCE:** This research elucidated the most physically demanding job tasks within the AFO-CT role profile to subsequently inform the development of a MOD armed policing PES.

Figure 1: Overview of Down-Selection Process of Physically Demanding Tasks

Number of Tasks Excluded		Number of Tasks Included
	Focus Group: Raw Tasks Individually listed by focus group participants	112
10	Focus Group: Decision 1 Agreement task is too broad or covered elsewhere?	102
89	Focus Group: Decision 2 Duplicate / similar tasks grouped	13
2	Focus Group & Governance Board: Decision 3 Agreement task is: Essential and role-related? Physically demanding? Generic to AFO-CT role?	11
	Online Survey: Criteria 1 Median criticality rating ≥4 out of 6?	11
3	Online Survey: Criteria 1 Median physical demand rating ≥4 out of 6?	8
4	Objective Monitoring Rank tasks on: Cardiovascular strain Accelerometery Addition factors	4
	SME Task Scenario Generation Workshop Concentration Combination Elimination	4 (2 scenarios)

THE DEVELOPMENT OF A PHYSICAL EMPLOYMENT STANDARD FOR THE AUTHORISED FIREARMS OFFICER – COUNTER TERRORISM NATIONAL ROLE PROFILE

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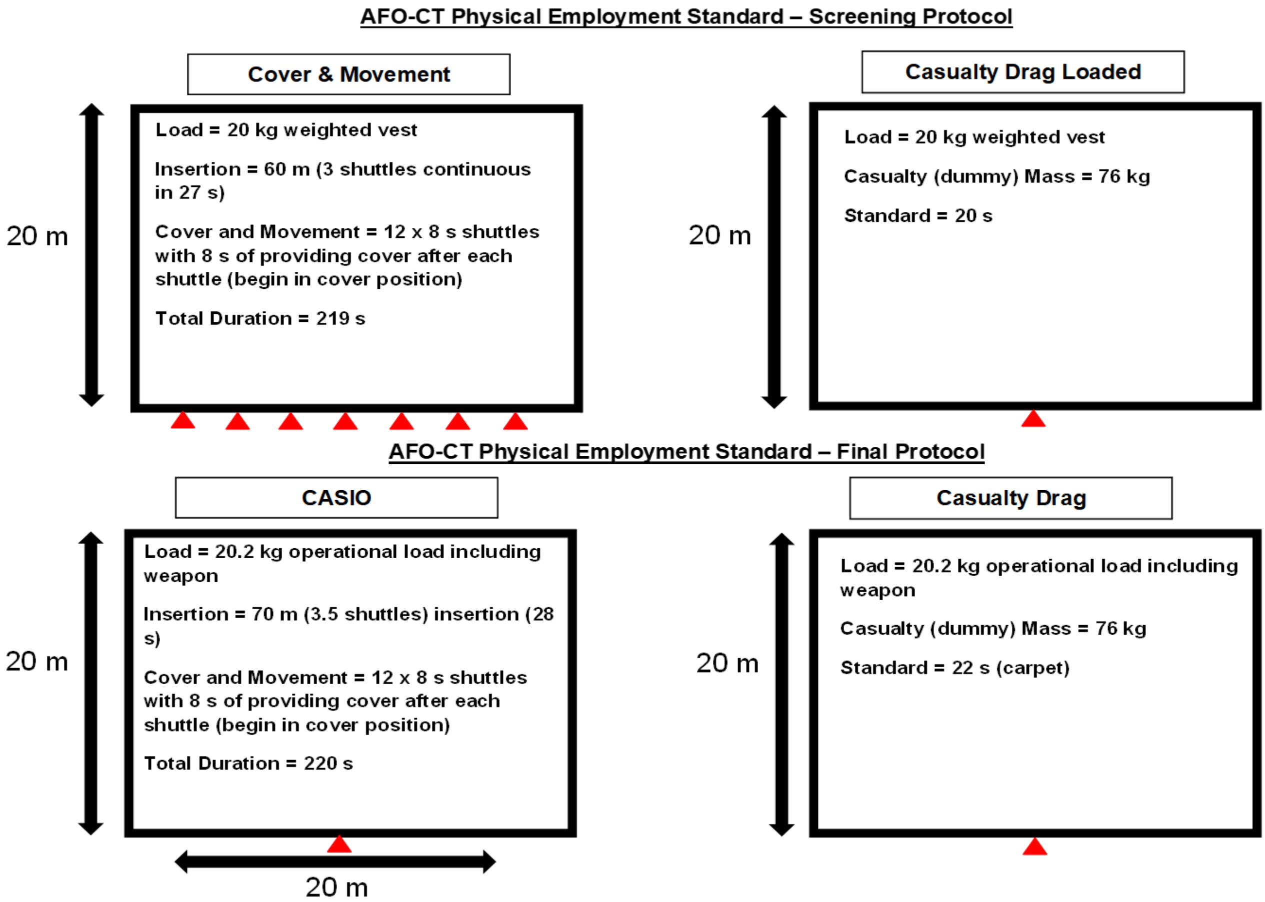
PURPOSE: The Ministry of Defence Police recognised the requirement to develop a Physical Employment Standard (PES) for the Authorised Firearms Officer – Counter Terrorism (AFO-CT) role profile. The purpose of this study was to develop PES testing options and subsequently evaluate their validity at predicting criterion tasks (Conduct Armed Search in the Open [CASIO] and Casualty Drag (76 kg casualty) performance. **METHODS:** Testing options were developed in consultation with subject matter experts based on the physical requirements of the criterion tasks. The criterion tasks had been previously defined as the most critical, physically demanding tasks within the role profile. Sixty-four (mean age = 39±9 years) serving AFO-CT officers (3% of officers)

completed both criterion tasks and all testing options to assess pass rates and test validity (sensitivity and specificity). Regarding CASIO, testing options were Cover and Movement Shuttles (CMS) and Cover and Movement Shuttles Unloaded (CMSU). Regarding Casualty Drag, testing options were Casualty Drag Loaded (CDL) and Casualty Drag Unloaded (CDU). The validity of the 20m Multi-Stage Fitness Test (MSFT) was also assessed. **RESULTS:** The sensitivity and specificity of CMS, CMSU and 20m MSFT were 100% and 33%, 89% and 100%, and 49% and 100%, respectively. The specificity of CMS was lower (i.e., higher proportion of false positives) owing to the test having a lower physiological demand than CASIO. Both CMSU and 20m MSFT had a lower sensitivity (i.e., higher proportion of false negatives) owing to the difference in physical requirements when compared with CASIO. CDL and CDU demonstrated a strong relationship with the criterion Casualty Drag (r^2=0.82 and 0.78, respectively) and good validity (sensitivity: 98% and 98%; specificity: 100% and 100%, respectively). **RELEVANCE:** Due to greater ecological validity and sensitivity (limiting false negatives), CMS (with slight timing modification) and CDL were recommended as the new AFO-CT PES (Figure 1).

Figure 1: Schematic of recommended AFO-CT PES.



Legend: Triangles represent participants.

INCIDENCES AND CAUSATIVE FACTORS OF LOWER LIMB INJURIES IN THE NEW ZEALAND ARMY

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PURPOSE: To examine long-term musculoskeletal injury trends in the New Zealand Army and determine the most common injuries and the activities serving as the causative factor. This information will be useful for identifying activities causing injuries and subsequent injury mitigation strategies. **METHODS**: Eleven years (2005-2015) of self-reported musculoskeletal injury data for the New Zealand Army (n=20461) were examined. Activities as causative factors were derived from a filtered narrative, completed by the soldier at time of injury. Three main activity categories were identified from the narratives: Military training, sport, and 'other'. Frequency data and Chi square analysis were carried out on injury anatomical site by activity. **RESULTS**: Cross tabulation revealed the ankle had the highest incidence of injury in military training and sport activities whereas the knee had the highest number of injuries in the category 'other' (X^2 (6, N = 860) = 91.56, $p < 0.001$). Military training activities produced the greatest amount of ankle injuries (X^2 (15, N = 3262) = 142.49, $p < 0.001$). Further analysis of sporting activities revealed that the ankle joint was the site with the highest number of injuries for indoor court sports, individual sports, and field sports. The knee was the site with the greatest number of injuries for contact sports; the lower leg and knee were the injury sites with the greatest number of injuries in other sports (X^2 (12, N = 2769) = 221.62, $p < 0.001$). **RELEVANCE**: Regardless of several interventions over 11 years, the overall injury rates did not change. Of the physical training and individual sport activities, running resulted in the most ankle injuries. These results will help inform defence forces when injuries are likely to occur. Future research is required to determine ankle injury aetiology.

LOWER LIMB INJURY PREVENTION IN THE NEW ZEALAND ARMY THROUGH TARGETED FOOTWEAR INVESTIGATION

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PURPOSE: The ability of New Zealand Defence Force (NZDF) to deploy personnel at short notice is compromised by the high number of musculoskeletal injuries, particularly to the lower limbs. The aim of this study was to examine the effects of a possible remedial intervention to mitigate the negative impacts of habitual boot-wear. **METHODS:** Key aetiological data were collected from 65 habitual boot-wearing regular force military male personnel pre- and post-introduction of a low-cut flexible shoe. These 65 Personnel had all served between 2.5 and 15 years in the NZDF. At 10 weeks, the effects of pre- and post- flexible shoe wear were measured to determine if the effects of habitual boot-wear could be reversed. Measurements were: ankle range of motion (ROM), endurance strength, power and fatigue of the ankle joint muscles (measured using an isokinetic dynamometer (Biodex)), muscle activation (electromyography) of the tibialis anterior

and both the medial and lateral gastrocnemius – quiet standing for 14 seconds on a force platform to measure postural sway). **RESULTS**: After 10 weeks of transitioning from habitual military boot-wear to a flexible shoe, paired analysis shows inversion and eversion were significantly increased by 27% and 39% respectively. The effect size for inversion (d = 0.9) and eversion (d = 0.9) was found to exceed Cohen's (1988) convention for a large effect (d – 0.8). Average work fatigue of the plantar flexors measured at 120°/s significantly decreased from 34.9% to 26.3% from pre- to post-shoe wearing with a mean fatigue index decrease of 8.7%. The results of centre of pressure (COP) area and speed in anterior-posterior and medial-lateral directions were significantly decreased (50% decrease in ellipse area) post 10 weeks shoe wear in comparison to pre-test. There was a significant decrease in gastrocnemius medialis and lateralis electrical activities and variability at post-intervention compared to pre-intervention for the postural control balance test. **RELEVANCE**: Chronic military boot-wear causes adverse adaptations to the ankle joint and the supporting muscles and is associated with the high number of ankle injuries in the NZDF, however the effects can be reversed. It was advised that when not on military maneuvers that personnel wear a low-cut flexible garrison shoe.

EFFECTS OF A SINGLE-DAY PRE-ACADEMY PHYSICAL TEST EDUCATION SESSION ON PHYSICAL FITNESS SCORES OF POLICE CANDIDATES

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PURPOSE: Concerns are sometimes raised by police applicants undertaking physical fitness testing that they were unfamiliar with the test requirements which in turn negatively impacted their performance. The aim of this study was to investigate the effects of a single-day, pre-academy, physical test education session on physical fitness scores of police candidates. **METHODS:** The sample consisted of female police candidates (n=133) who attended pre-academy training organized by the University of Criminal Investigation and Police Studies (UCIPS), Belgrade, Serbia. On the first day of pre-training, candidates' physical fitness was measured in the same way as it would on the official assessment day. It included briefing on the rules for each test. Fitness tests for the enrolment of female candidates to UCIPS included maximal handgrip strength, number of push-ups in 10 sec (PU), number of sit-ups in 30 sec (SU), standing long jump (SLJ), Abalakov jump test (AJ), 2.4km Cooper running test (CT), and a motor educability test (ME). After the assessment, the overseeing UCIPS staff provided a detailed test skills briefing to candidates on common mistakes during testing, how test performance could be improved, etc. Immediately after the briefing, candidates performed the tests once again to consolidate feedback. **RESULTS / PRELIMINARY RESULTS:** Paired sample t-tests determined significant ($p<0.001$), large (Rank-Biserial Correlation = 1.00), improvements in physical fitness scores during the second assessment following familiarisation and feedback on test performance (See Table 1 for full results). **RELEVANCE:** Pre-academy

education is effective in improving candidates' physical fitness scores, in most tests, prior to the official assessment for the enrolment to police studies.

Table 1: Results of the two assessments expressed as mean±SD.

Activity	Test 1	Test 2	*p* Value
Grip Strength (kg)	34.2±4.9	34.8±5.2	0.45
Push-ups (repetitions)	1.4±2.3	2.0±2.6	<0.001
Sit-ups (repetitions)	14.5±4.0	18.5±3.6	<0.001
Standing Long Jump (cm)	145.7±24.2	151.2±24.3	<0.001
Abalakov Jump Test (cm)	22.5±8.1	26.4±5.1	<0.001
Motor Educability Test (number of mistakes)	20.5±5.3	10.4±6.0	<0.001
Total Score	3.5±2.8	5.6±3.0	<0.001

*Total score calculated by a formula which employs factorial and multiple regression analysis with the z score presented in the range of 0-20. The formula contains the coefficient for each test multiplied by the achieved result.

A PROFILE OF INJURIES SUFFERED BY FEMALE SOLDIERS SERVING IN THE AUSTRALIAN ARMY

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PURPOSE: Conditioning for physically demanding occupations in hampered by injury, yet little research has been performed to investigate differences in injuries reported by female and male personnel. The aim of this study was to compare injury rates and patterns between female and male soldiers of the Australian Regular Army (ARA). **METHODS:** Data pertaining to all injuries reported by ARA members over a two-year period were accessed from the SENTINEL database and analysed descriptively. Findings regarding injury patterns were reported by most common location, nature, mechanism, severity, and activity being performed at the time of injury. Injury incidence rates (IR) were calculated based on population size, and injury incidence rate ratios (IRR) comparing female and male injury rates were determined. **RESULTS:** A total of 8750 injuries were recorded across the two-year period (minor injuries: n=1766 female, n= 6870 male; serious injuries: n= 19 female, n = 95 male). Higher incidence rates of minor injuries were reported for female soldiers (IR=20.75 injuries/100 soldiers/year) when compared to male soldiers (IR=13.60 injuries/100 soldiers/year), with an IRR of 1.53 [95% CI = 1.46-1.60] (Table 1). More serious injuries were reported at a similar rate between female (IR=0.22/100 soldiers/year) and male soldiers (IR=0.21/100 soldiers/year), with an IRR of 1.05 [95% CI = 0.65-1.72]. Female soldiers reported more ankle injuries than male soldiers who reported more knee injuries. Physical

training and combat training were the most common causes of injury for both sexes. **RELEVANCE:** There were subtle differences in body locations of minor injuries between female and male soldiers with minor and more serious injuries otherwise similar between sexes. Strategies to minimise injuries in female soldiers may be similar in many respects to strategies for male soldiers but should consider the subtle differences in body locations of injury to ensure effectiveness across all personnel.

Table 1: The most reported locations of minor injury in female, when compared to male soldiers.

Location	Female	Male	IRR [95% CI]
Ankle	255 (3.00, 14.4%)	856 (1.69, 12.5%)	1.77 [1.54-2.03]
Knee	190 (2.23, 10.8%)	878 (1.74, 12.8%)	1.28 [1.10-1.50]
Low Back	122 (2.60 6.9%)	596 (1.18, 8.7%)	2.20 [1.81-2.67]
Foot	101 (1.19, 5.7%)	218 (0.43, 3.2%)	2.75 [2.17-3.48]
Shoulder	*101 (1.19, 5.7%)*	*535 (1.06, 7.8%)*	*1.12 [0.91-1.38]*
Collated others*	997 (11.71, 56.5%)	3787 (7.50, 55.1%)	1.56 [1.46-1.67]
TOTAL	**1766 (100%)**	**6870 (100%)**	**1.53 [1.46-1.60]**

*Collated others < 90 injuries for females, < 213 injuries for males. Results reported as number of injuries (injuries/100soldiers/year, % of injuries). IRR reference group = males. Top three most common Minor Personal Injuries (MPI).

PARAMEDIC PHYSICAL FITNESS REQUIREMENTS AND PHYSICAL PREPARATION OF STUDENTS FOR THE PARAMEDIC ROLE: A NARRATIVE REVIEW.

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PURPOSE: To summarise evidence and identify knowledge gaps regarding physical demands and fitness requirements for a paramedic role; existing fitness testing and physical employment standards (PES); and how paramedic students are physically prepared within tertiary education for the paramedic role. **METHODS:** A range of sources such as electronic databases (e.g., CINAHL), reference lists, and search engines indexing grey literature were searched using the PCC framework as shown in Table 1. The search was conducted to identify published peer reviewed studies and grey literature providing evidence on these topics. **RESULT:** The available evidence identifies paramedics as an unhealthy population, and indicates paramedics have a physically demanding role and there is a need for pre-employment fitness testing and fitness

maintenance. However, there appears to only be regular fitness monitoring and testing in specialised roles. This population suffers a high incidence of injury, cardiovascular disease, and obesity. Existing pre-employment fitness requirements are often unclear in how they link to the role of the paramedic, inconsistent between paramedic services, and unvalidated, without published physical demands analyses and PES. Minimal preparation, if any, is provided to student paramedics for the physical aspects of the paramedic role. **RELEVANCE:** Australia's existing paramedic pre-employment physical fitness assessments are not standardised across jurisdictions and frequently do not appear to directly relate to the essential requirements of the role. There is increasing evidence of the need for standardised essential minimum levels of fitness, that are based on the identified physical demands of the daily tasks performed by paramedics. There is minimal literature regarding student and graduate paramedics' physical fitness and physical activity levels, as well as preparation needs for the role. Physically prepared student paramedics along with validated physical fitness screening assessments are vital to paramedic physical health, safety, longevity in the role, and the efficient provision of patient care.

Table 1: *PCC framework*

Populations	Paramedic, EMT, emt, Emergency Medical Technician. Student paramedic, paramedic student, student of paramedicine
Concepts	Physical health, fitness, pre-employment fitness testing, physical employment standards, physical training, physical activity, fitness training, physical capacity.
Contexts	Australia, Canada, England, South Africa (Contexts selected have similar ambulance systems)

DEVELOPING A RETURN TO WORK ASSESSMENT FOR AN INJURED POLICE OFFICER: A CASE REPORT

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PURPOSE: Officer wellness includes ensuring that physically injured officers can return to work (RTW) safely. The only way to ensure this safe return is through a fit-for-duty test. This case report details strategies of the successful RTW for an injured police officer derived from fit-for-duty testing. **METHODS:** A content-valid, job-specific test was used to evaluate officers' ability to do their job safely following a Grade 3 Hamstring muscle strain. The process involved clearly defining what tasks were required to complete daily work, then identifying the essential physical demands and movements of these tasks. The latter was done through surveying officers and task observations and measuring. Subsequently, a physical test was designed. Incumbent employees validated this test. With the content-valid approach, the fit-for-duty test was used to objectively evaluate the physical and functional ability of the officer in preparation for RTW. **RESULTS / PRELIMINARY RESULTS:** The RTW assessment for the officer represented in this case report is detailed in Table 1. The test elements were conducted in any order in a single session. Outcomes of the assessment saw no working days lost with the implementation of light duties immediately. The officer was cleared to RTW 4 weeks before expected following the successful

competition of the fit-for-duty testing. The officer had no subsequent complications and continues to compete in CrossFit, golf, and skiing. The city saved $10,710 in indirect costs from overtime and light-duty wages. **RELEVANCE:** Using a content-valid method with a kinesiophysical approach, fit-for-duty testing protocols can be developed for individuals to objectively evaluate their physical and functional ability as a measure of RTW readiness. Further, the information not only educates the individual regarding their abilities and limitations, but it also acts as a catalyst for the design of treatment programs that focus on safe RTW.

Table 1:

Essential Function	Fit For Duty Test
1. Patrol – foot/bike/vehicle (squad) take appropriate action on matters affecting public safety using problem-solving strategies	a. Lift/Carry 23lbs level 4 protective vest/belt while on duty, 12 hours, may take breaks. ➢ Wear 23 lbs protective vest for the duration of test b. May sit up to 60 minutes at a time while conducting vehicle patrol activities. ➢ Sit for 15 minutes while completing intake paperwork ➢ Stand/walk for the duration of test c. Climb up and down 102 steps (6 story building) ➢ Climb up and down 102 steps
2. Investigate: traffic accidents and road obstructions- moving barriers or people. missing persons, violators, or property damage, crimes, or complaints.	a. Lift 100lbs people (shared, total weight at least 200lbs) from 0 inches, carry 20 feet, place at 0 inches ➢ Lift/carry 50lbs from 0 inches, carry 20 feet, place at 0 inches ➢ Lift/carry 65lbs from 0 inches, carry 20 feet, place at 0 inches ➢ Lift/carry 80lbs from 0 inches, carry 20 feet, place at 0 inches ➢ Lift/carry 100lbs from 0 inches, carry 20 feet, place at 0 inches b. Pull while dragging 200lbs to move people from the ground at 0 inches to a safe area at waist height / 36 inches up to 30 feet ➢ Pull while dragging 200lbs from the ground at 0 inches at waist height/36 inches – 30 feet c. Climb ladder: 15 rungs to access the roof or other areas to search for evidence ➢ Climb ladder: 15 rungs up and down
3. Apprehend/ Transport violators	a. Grip 40lbs of force on each hand, position 2, for a non-compliance hold on a violator for 30 seconds ➢ Grip, preferred height, 40lbs of force for 30 seconds b. Push (preferred) 70lbs at 36 inches (waist height) on the resistive subject to control for at least 30 seconds ➢ Push (preferred) 70 lbs at 36 inches (waist height) for 30 seconds c. Pull (preferred) 100lbs at 36 inches (waist height) on the resistive subject to control for at least 30 seconds ➢ Push (preferred) 100lbs at 36 inches (waist height) for 30 seconds d. Push (down) while kneeling 110lbs at 0 inches on the resistive subject to control for up to 30 seconds ➢ Push (down) while kneeling 110lbs at 0 inches for 30 seconds e. Other: Run up to 100 meres during a foot chase ➢ Run up to 100 metres at a self-selected pace f. Climb Vertical Ladder: Climb up and over at least 4 feet chain link fence while responding to a call ➢ Climb up and over 4 feet chain link fence x 2 reps

FACILITATING PHYSICAL TRAINING VARIABILITY THROUGH EXPANDING TEST SELECTION OPTIONS

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PURPOSE: This narrative review and theoretical discussion aims to promote an evolution of the cultural paradigm from deploying a set of specified physical test events to permitting event selection from groups of approved events across key performance constructs (i.e., aerobic capacity, muscular strength). It will identity the empirical and logistical support for enhancing diversity of test selection to provide multiple options for assessing Soldier physical readiness. **METHODS:** Combat fitness tests are often designed by comparing the statistical relationships between testing events and common Soldier tasks (CSTs). The goal is to find a valid, repeatable, and easily executed set of events that holistically assess the physical capabilities required to successfully perform CSTs. Moreover, the events' metrics should provide sufficient detail to drive strength and conditioning planning, track progression, and inform programmatic decisions. Often, several events can reach a concordance correlation coefficient criterion for construct validity to an accepted gold standard metric (GSM; e.g., VO_{2Max}). Thus, the US Army Occupational Physical Assessment Test and Army Combat Fitness Test performance constructs were compared with logistically scalable lab- and field-based events to identify multiple acceptable surrogate options. **RESULTS:** An analysis of the literature indicated most physical performance constructs have at least 3 to 5 events that accurately and reliably explain a large variance in the targeted GSM (Table 1). Therefore, with proper data normalisation, these events could be employed interchangeably to assess the underlying capability. **RELEVANCE:** Leveraging a greater range of potential options for physical testing events may increase the variability of self-selected training practices, without sacrificing the ability to infer performance transfer to CSTs. In turn, this shift could help facilitate better understanding and application of holistic health and fitness principles across the enterprise. It could significantly decrease the occurrence of overuse injuries and promote a more resilient, operationally ready force.

Table 1: Physical Performance Constructs and Related Assessments

Performance Construct (Gold Standard Metric)	Assessment	Coefficient
Aerobic Capacity (VO_{2MAX})	10 km Run	0.88 – 0.95
	Cooper 12-minute	0.89 – 0.91
	MSFT/Beep/PACER test	0.76 – 0.94
	3.218 km Run	0.84 – 0.91
Anaerobic Capacity (Watts or Watts/kg)	Bosco Jump Test	0.72 – 0.84
	274.32 m Shuttle	0.82 – 0.95
	RAST	0.76 – 0.89
	732 m Sprint	0.74 – 0.86
Muscular Power (Rate of Force Development)	Vertical Jump	0.82 – 0.95
	Broad Jump	0.79 – 0.91
	Seated Throw	0.76 – 0.88
	Standing Power Throw	0.74 – 0.90
	Power Clean	0.72 – 0.92
Muscular Strength (Repeated Maximal Force)	≤ 5 Repetition Deadlift	0.92 – 0.95
	≤ 5 Repetition Pullup	0.82 – 0.91
	≤ 5 Repetition Squat	0.76 – 0.90
	Loaded CMJ	0.84 – 0.94
	IMTP	0.80 – 0.93

MSFT = Multistage Fitness Test. PACER = Progressive Aerobic Cardiovascular Endurance Run. RAST = Running Anaerobic Sprint Test. CMJ = Countermovement Jump. IMTP = Isometric Mid-Thigh Pull.

INTEGRATING BIOSENSORS WITHIN BASIC COMBAT TRAINING: METHODOLOGY FOR TECHNOLOGY ENABLED HOLISTIC HEALTH AND FITNESS

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PURPOSE: Wearable biosensors may provide passive data on a Soldier's readiness, workload, and recovery dynamics. This information can help drive programmatic decisions for selection, training, and support across physical, nutritional, mental, and sleep domains. As these technologies evolve and are naturally adopted by end users, it is critical to execute large scale integration tests and evaluations (T&E) on their capability for reliably capturing key performance indicators, then document lessons learned and best practices into doctrine for implementation across the enterprise. **METHODS:** This discussion will detail the methodological approach in development for an FY23 T&E within the US Army Basic Combat Training (BCT) pipeline. It will

summarise the extant literature to identify wearable-based biomarkers relevant to holistic health and fitness. Supporting equipment, processes, data workflows, and personnel requirements will be reviewed. Current technical limitations will be highlighted to drive industry developments. **RESULTS:** Biosensor integration into BCT may provide critical resources to understand Soldiers' internal and external states as they execute training demands. To optimise biosensor utilisation for holistic health and fitness initiatives, T&E must be combined with empirical investigations and disseminated across the force (Table 1). **RELEVANCE:** Commanders and instructors can leverage wearable data to evaluate Soldiers' baseline, daily, and pre/post training performance-enabling physiological statuses to better inform personnel and programmatic decisions. Soldiers can gain better insights into how their behavioral decisions impact mission readiness, their ability to handle operational workloads, and how best to optimise personal recovery. The integration and utilisation of wearables into BCT and the operational force could significantly decrease the occurrence of overuse injuries and attrition by providing biofeedback aimed at promoting individual and group behavioral choices that lead to a more resilient and ready force.

Table 1: Tactical Wearable Devices, Key Metrics, and H2F Readiness Domains

H2F Readiness Domain	Biomonitoring Metric	Wearable Device(s)
Physical	Heart Rate	PG, PH^, GF, GC, FB, O, A, F, W
	Heart Rate Reserve	PG, PH^, FB
	Time in Zone	PG, PH^, GF, GC, FB
	TRIMP	PG, PH^, GF, GC, FB
	Heart Rate Variability (Wake)	PG + PH, PH^, GF, FB, O, A
	Steps	PG, PH^, GF, GC, O, A, F
	Distance	PG, PH^, GF, GC, O, A, F, W
	Pace/Speed/Cadence	PG, PH^, GF, GC, O, A, F, W
Nutritional	Caloric Expenditure	PG, PH^, GF, GC, FB, O, A, F, W
	Substrate Utilization	PG, PH^, GF*, GC*, A*
	EPOC	GF, GC, FB
Mental	Heart Rate Variability	PG + PH, PH^, GF, GC, FB, O, A, F, W
	Heart Rate Acceleration	-
	Heart Rate Deceleration	-
	Electrodermal Activity	F
Sleep	Sleep Time	PG, GF, FB-BG, O, A, F, W
	Sleep Staging	PG, GF, O, A, F, W
	Sleep Efficiency	PG, GF, FB-BG, O, A, F, W
	Heart Rate	PG, GF, FB-BG, O, A, F, W
	Heart Rate Variability (Night)	PG, GF, FB-BG, O, A, F, W
	SPO2	GF, O, A, F, W

PG = Polar GritX series watch. PH = Polar H10 chest strap. GF = Garmin Fenix series watch. GC = Garmin HRM-Pro Plus chest strap. FB = FirstBeat Sports Pro chest strap. FB-BG = FirstBeat BodyGuard. O = Oura. A = Apple Watch Ultra. F = Fitbit. W = Whoop. TRIMP = Training Impulse. EPOC = Excess Post-Exercise Oxygen Consumption. *Requires download of additional third-party application. ^Requires phone or tablet access.

HEART RATE VARIABILITY PROFILE CHANGES ASSOCIATED WITH SLEEP, LESS-LETHAL EXPLOSIVE DEVICE EXPOSURE, AND FEAR OF HEIGHTS TRAINING IN SPECIALIST POLICE SELECTION

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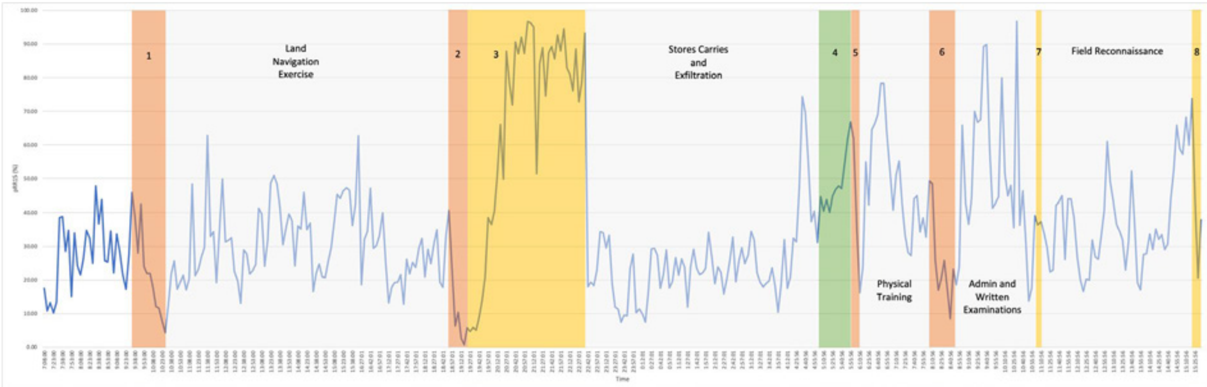
PURPOSE: Specialist police units within Police Tactical Groups (PTG) are tasked with a wide scope of duties, many of which are potentially hazardous. Consequently, the selection of individuals for service must also be rigorous and include relevant occupationally derived challenges. Given the risks and intensity of selection, health and performance monitoring may benefit both personnel and commanders. Heart Rate Variability (HRV) is one holistic measure obtainable through wearable technology monitoring. As such, the purpose of this case study was to profile HRV, specifically pRR15 (percentage of adjacent R-R intervals varying by at least 15ms) during a during PTG selection course as this HRV method is reported in epidemiological research. **METHODS:** Participants (n=6) attempted a 36-hour PTG selection course held at an Australian state facility. All participants provided written informed consent and the unit commander provided approval for publication. Participants were qualified police officers wearing Equivital™ EQ02+ LifeMonitor (ADInstruments, Sydney, Australia) devices, recording 2-lead ECGs for HRV analysis. The selection course consisted of physically demanding events (e.g., physical training, navigation exercises, and load carriage events) with minimal sleep (approx. 45 mins). **RESULTS:** Of the six candidates, only one completed the course; whose results are reported here. Rapid declines in HRV were observed during the planning of the navigation exercise and pack march with volatility noted throughout the exercise, awakening to the deployment of a less-lethal device, throughout a fear of heights testing task, and lastly during a room clearance and simulated threat elimination drill (Figure 1). Increases in pRR15 were observed throughout the pack march exercise, rest period, de-escalation simulation, and immediately following the room clearance task and conclusion of training. **RELEVANCE:** HRV may potentially inform stakeholders regarding stress levels of candidates undergoing PTG selection and serve as a component of a holistic matrix assessing the overall suitability of PTG candidates.

Figure 1: pRR15 HRV characteristics of an Australian PTG candidate obtained in 5min intervals. The field highlighted in green indicates a rest period from 0520-0600. The fields highlighted in orange indicate periods of rapid decline in HRV. Fields highlighted in yellow designate particular key events in the selection course.



Legend 1. Travel to and planning of navigation exercise, 2. Pack march planning, 3. Pack march exercise, 4. Rest period, 5. Less-lethal device deployment, 6. Fear of heights evaluation, 7. De-escalation simulation, 8. Room clearance and simulated threat elimination drill. Events within the shaded light grey areas are described within the figure.

COMPARISON OF PHYSICAL DEMANDING PARAMEDIC WORK TASKS BETWEEN AN AUSTRALIAN AND CANADIAN AMBULANCE SERVICE

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PURPOSE: Ambulance services require candidates to pass physical employment tests (PETs) to be deemed suitable for the paramedic role. Some research has been undertaken to improve these tests. However, assessments are often arbitrary measures of fitness, rather than task specific. This study aimed to determine if a job task analysis and physical tasks checklist developed for one ambulance service were applicable to a separate ambulance service. **METHODS:** Job task analysis and the resultant creation of two physical tasks checklists was completed for a Canadian ambulance service. These checklists were replicated, with minor modifications to ensure local relevancy, for use in Ambulance Victoria (AV). Paramedics (n=18, age = 34±9 years, experience = 7±7 years) completed the checklists over one roster cycle, 12-16 shifts. Tasks were rated by rate of perceived exertion (RPE) and categorised into frequent tasks and strenuous task lists. **RESULTS:** Patient conveyance tasks (such as transferring non-ambulatory, vital signs absent, and obese patients) were similar in frequency and description across services. However, stretcher handling and maneuvering tasks such as raising stretcher

to loading height with patient and loading the stretcher into the ambulance was rated >7/10 by 87% and 85% of Canadian respondents respectively. These tasks were rated >7 RPE by 6% of AV respondents. **RELEVANCE:** Research into paramedic physical employment standards and PETs is scarce. This the first known study to assess differences in job tasks between different paramedic services and serves to increase the collectively knowledge of the physical demands of this complex profession. Although many of the physical tasks were similar, there were sufficient differences that indicate service-specific PETs are required. Service specific job task analysis is required to develop PETs that ensure employees are specifically selected to meet the requirements of that service.

ISOKINETIC SHOULDER STRENGTH IN TACTICAL POPULATIONS: A CRITICAL REVIEW

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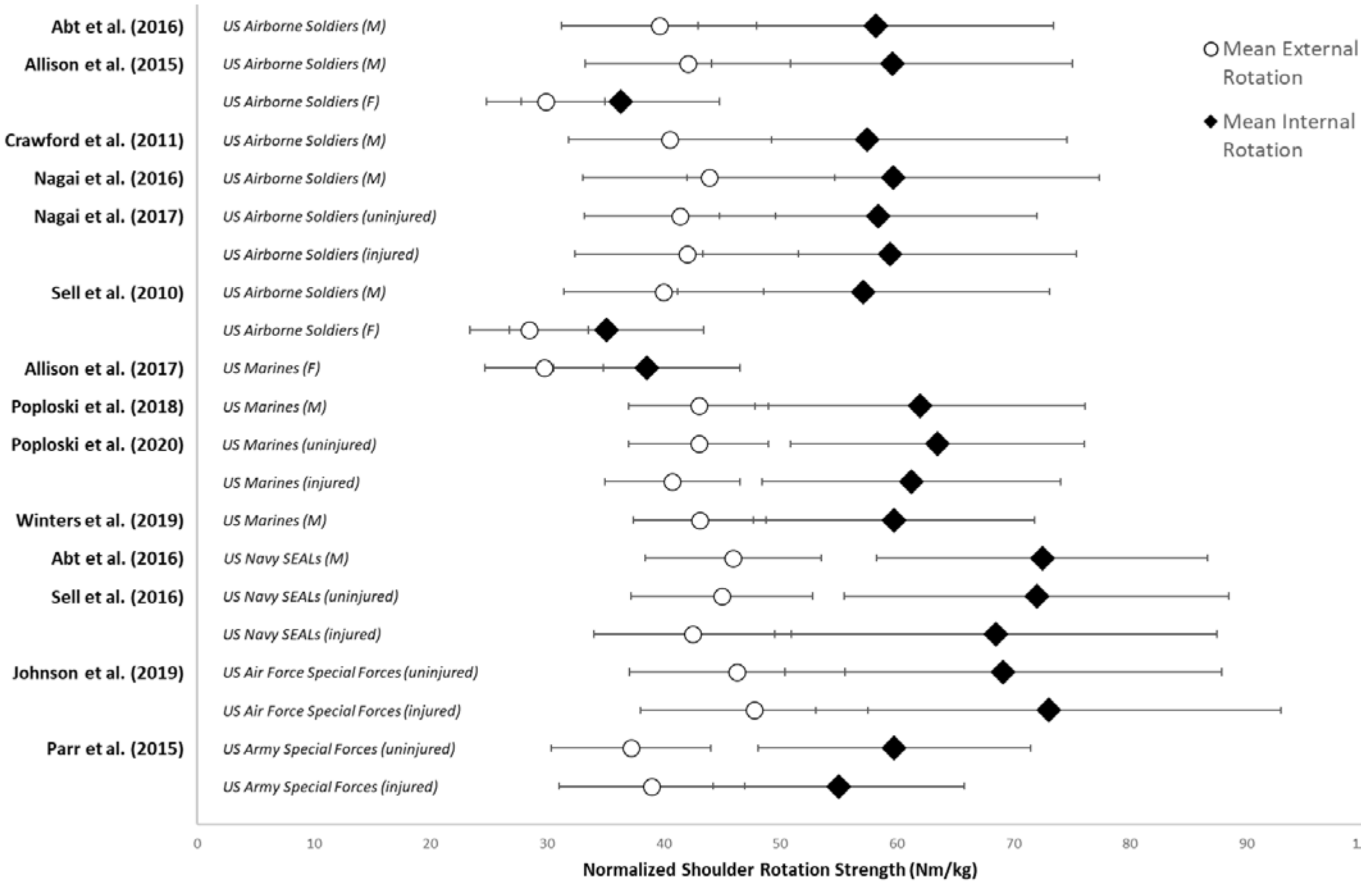
PURPOSE: The aims of this review were to perform a systematic search for protocols examining isokinetic strength of the shoulder in tactical populations (police, firefighters, and military personnel), profile strength patterns within these populations, and investigate correlation to injury. **METHODS:** Four electronic databases were searched in February 2022 (Medline/Pubmed, Ovid/Emcare, CINAHL/Ebsco and Embase) in accordance with PRISMA guidelines yielding 275 studies. Articles were eligible if they 1) had at least one cohort of a tactical subpopulation, and 2) included isokinetic testing of the glenohumeral joint. After duplicate screening and applying the inclusion criteria this left 19 articles, six of which evaluated injury association. **RESULTS:** 17 articles evaluated military personnel, with most utilizing concentric internal rotation (IR) and external rotation (ER) strength at 60 degrees/second. Only two studies evaluated firefighters, and none examined police or law enforcement. There was a paucity of testing speeds, repetition ranges, and contraction types evaluated when compared to literature on other populations with similar injury profiles. Strength data is presented in the forest plot below (Figure 1). Meta-analysis was unable to be performed on injury data due to study heterogeneity regarding independent variable selection and lack of summary statistic data. However, a best evidence synthesis suggested conflicting evidence to support the association of injury with isokinetic shoulder testing in tactical populations. **RELEVANCE:** Outside of military cohorts, there is limited data available to characterise the isokinetic strength profile of the shoulder in tactical occupations. Future isokinetic research in tactical occupations should aim to increase the depth of evaluation given the various physical demands in these occupations. Specifically, the inclusion of higher repetition endurance testing and eccentric contractions may better outline weaknesses in the strength-velocity curve of tactical cohorts. This could lead to the development of strength profiles and ratios that are unique to tactical cohorts' injury risk.

Figure 1: Bodyweight normalized MVCC shoulder strength.



Legend: M = Male, F = Female

Thank you for your attendance.