PHYSIOLOGICAL AND PHYSICAL EMPLOYMENT STANDARDS I

Proceedings of the First Australian Conference on Physiological and Physical Employment Standards

Editors:
Nigel A.S. Taylor and Daniel C. Billing

November 27th-28th, 2012
CANBERRA, AUSTRALIA

Australian Government
Department of Defence
Defence Science and Technology Organisation

UNIVERSITY OF WOLLONGONG

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Nigel A.S. Taylor and Daniel C. Billing

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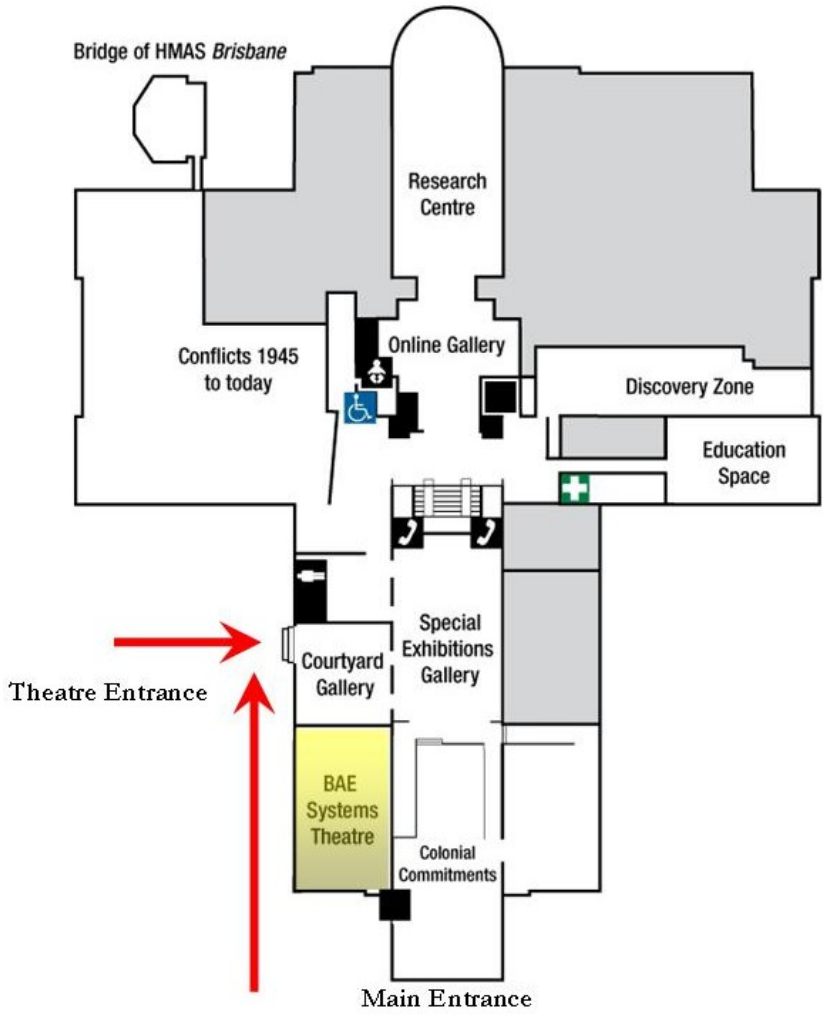
Australian War Memorial (lower level): BAE Systems Theatre



AUSTRALIAN Conference on Physiological and Physical Employment Standards (1st; 2012; Canberra, Australia)

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PREFACE:

Welcome to the ***First Australian Conference on Physiological and Physical Employment Standards*** (AusPES). This conference focusses upon the development, implementation and justification of employment standards within physically demanding occupations. It is an initiative of the Defence Science and Technology Organisation, supported both financially and administratively by the University of Wollongong, and organised through its Centre for Human and Applied Physiology (http://www.uow.edu.au/health/chp/index.html), a collaborative research link between these two organisations.

It is a great honour to host this meeting within such a congenial environment, and in so doing, provide leading scientists from around the world with an opportunity to present their research on this very important aspect of applied human physiology.

Many national and civil organisations require workers to operate within physically demanding conditions, often at very high intensities, and such organisations face the dual obligations of delivering a highly capable and injury-resistant workforce. Within such conditions, survival is dependent upon personal protective clothing, protective equipment and a vast array of life-supporting apparatus. Indeed, technological developments across these protective ensembles have allowed workers to be deployed into environments not previously encountered. Yet this protective equipment itself places a burden upon the worker. Thus, when seeking people to take up these jobs, organisations must also wrestle with issues concerning duty of care and non-discriminatory work practices across a diverse array of contemporary societies.

We thank our keynote speakers for supporting this initiative, we thank speakers from eight countries who, like us, recognise the importance of this research field, and we thank delegates who have travelled from afar to listen to, and to participate within these important discussions.

We wish all delegates a stimulating, enjoyable and productive meeting, and a safe return home, having enjoyed our beautiful country and our hospitality.

Dr. Alex Zelinsky
Chief Defence Scientist
Defence Science & Technology Organisation

Professor Paul Wellings
Vice Chancellor
University of Wollongong

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SUPPLEMENTARY MATERIAL:

European Journal of Applied Physiology: 2012

Over the past three years, the publication of reviews within this journal has moved from primarily unsolicited reviews to the publication of reviews by invitation only. In the second stage of this development, the Editorial Board introduced **Invited Thematic Reviews** in which authors from several laboratories would be invited to write research overviews covering closely related, thematic topics. The development of the first four themes is well under way, and these are:

Space physiology (in print)
Physiological employment standards (in press)
Blood pressure regulation outside the comfort zone (2013)
Transcutaneous water loss, heat dissipation and clothing (in preparation).

In preparation for this conference, and with the support of the journal, 17 scientists contributed to thematic overviews that covered the physiological, applied and legal considerations that influence the development and implementation of valid physiological employment standards. The papers below constitute this series. Electronic reprints may be obtained directly from the journal (http://www.springerlink.com/content/100513) or from the lead authors.

Physiological employment standards I: Occupational fitness standards: objectively subjective?
Michael J. Tipton, Gemma S. Milligan and Tara J. Reilly {*P 11 of these proceedings*}

Physiological employment standards II: Developing and implementing physical employment standards for safety-related occupations.
Veronica Jamnik, Robert Gumienak and Norm Gledhill {*P 29 of these proceedings*}

Physiological employment standards III: Physiological challenges and consequences encountered during international military deployment.
Bradley C. Nindl, Marilyn A. Sharp, John W.Castellani, Bradley Warr, Paul Henning, Barry Spierling and Dennis Scofield {*P 61 of these proceedings*}

Physiological employment standards IV: Integration of women in combat units – physiological and medical considerations.
Yoram Epstein, Ran Yanovich, Daniel S. Moran and Yuval Heled {*P 46 of these proceedings*}

Amercian College of Sports Medicine: 2013

At the Sixtieth Annual meeting of this organisation (2013), there will be a two-hour symposium dealing with the establishment and implementation of physiological employment standards:

Applying Performance Standards in the Workplace - Current Issues.
Speakers: Michael J. Tipton, Daniel C. Billing, Glen P. Kenny and Nigel A.S. Taylor
http://www.acsm.org/attend-a-meeting/2013-annual-meeting

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SESSION FIVE: ORAL PRESENTATIONS (15:25-16:35): *FOCUS*: Fire fighting:

SESSION SIX: ORAL PRESENTATIONS (16:50-17:45):

MUSEUM TOUR (guided - 18:00-18:30 - groups of 20)

CONFERENCE DINNER (BBQ: The Terrace: 18:30-20:00)

Located on the right-hand side of the Main Entrance.

INFORMAL SOCIAL GATHERING (Mercure Hotel: 20:00 onwards)

Historic Hotel Ainslie (1927):corner of Ainslie and Limestone Avenues.

END OF DAY ONE

BAE SYSTEMS THEATRE: Wednesday 28th November

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SESSION TEN: POSTERS (Courtyard Gallery: Posters over Lunch: 12:20-13:00):

Closing Address: Simon Oldfield, Chief Human Protection and Performance Division, Defence Science and Technology Organisation (Australia).

CONFERENCE CLOSES (17:45)

END OF DAY TWO

FITNESS STANDARDS: OBJECTIVELY SUBJECTIVE?

Michael J. Tipton[1], Gemma S. Milligan[1], Tara J. Reilly[2]
[1]Department of Sport and Exercise Sciences, University of Portsmouth, UK
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KEYNOTE PRESENTATION

This paper will examine the process involved in the establishment of a minimum fitness standard with particular reference to the subjective decisions that must be made in order to produce a standard, and where this leaves a resulting standard in terms of its validity and defensibility. In general, the development of a minimum fitness standard involves the following steps:

- Task analysis to identify the critical physically demanding task – determination of the number and type of task to be included
- Determination of the "Method of Best Practice" for undertaking the critical tasks
- Agreement on the acceptable minimum level of performance on the critical tasks
- Establishment of the physical and physiological demands associated with these tasks and decide whether to use the min, max, average, percentile, mode, median etc. of these data in formulating the fitness test
- Determination of the percentage of an individual's maximum capability it is reasonable to expect them to work at
- Production of a minimum fitness standard:
    - Decide whether to use task simulations or predictive tests – consider how to handle the imprecision (variability) of predictive tests
    - Decide how to handle the false positives and negatives that will be produced if predictive tests are used in the standard.

It should be apparent from the above, that whist some aspects of the production of a minimum fitness standard can be established objectively and with great accuracy, other aspects are founded on informed opinion. These aspects are considered in more detail in the full paper, and the consequence for the utility of such standards is discussed in the context of them being challenged.

NOTES:

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A RECOMMENDED FITNESS STANDARD FOR THE OIL AND GAS INDUSTRY.

Gemma S. Milligan[1], James R. House[1], Michael J. Tipton [1],
[1]Department of Sport and Exercise Sciences, University of Portsmouth, UK
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INTRODUCTION

The Energy Institute (UK) wished to recommend a minimum fitness standard for the Oil and Gas Industry. The Oil and Gas Industry covers both onshore and offshore facilities, owned and managed by commercial organisations. Currently the suitability of individuals to work in the industry is assessed by medical examinations and basic health assessment tools; therefore selection is based on "medical" fitness, with little consideration given to "physical" fitness criteria.

METHODS

The following approach was adopted: Review the tasks requiring a significant physical fitness component (Task analysis); Determine the importance of the physically demanding tasks and identify those which are critical for success and safe work (Task assessment); Establish the method of best practice (technique) for undertaking the critical tasks; Establish and agree the minimum performance standard for the critical tasks (Task performance) when performed using the method of best practice; Assess the physical and physiological demands of these tasks (Task quantification); Design a simple-to-administer minimum fitness standard .

RESULTS

The essential tasks and the minimum fitness requirements to perform these tasks were: Stair and Ladder climbing - aerobic standard of 23.4mL.kg^{-1}.min^{-1} based on the requirement to climb a flight of stairs at a rate of 80step.min^{-1} and 23.6mL.kg^{-1}.min^{-1} to climb a ladder at 24rungs.min^{-1}; Manual Handling - a whole body strength standard based on the requirement to climb a flight of stairs at a rate of 80step.min^{-1} for a minute carrying either 10kg, 20kg or 25kg; Valve Turning - a local muscular strength/endurance standard based on the requirement to continuously turn a medium size valve (25.4cm diameter) set at a torque of 8.3N.m, for 5 min; Emergency Response Team - aerobic standard of 30.7mL.kg^{-1}.min^{-1}, based on the requirement to pull a trailer/foam monitor at a speed of 5km.h^{-1} or climb a ladder at 34.5rungs.min^{-1}. Aerobic standard of 28.9mL.kg^{-1}.min^{-1} if trailer/foam monitors are not used. Stretcher carry 89kg either in a two or four man lift ERT only), rope haul the heaviest anticipated load (10kg first aid kit) up 10m gantry (ERT only), roll out a 23m fire hose (ERT only). The fitness tests scores were set using the rationale that individuals should not work at greater than 75% of their maximum strength and/or aerobic capacity.

CONCLUSIONS

Jobs should be assessed, and depending on the physical characteristics of that job, the relevant fitness tests selected and administered, thus a modular fitness standard was recommended which included predictive selection tests and direct task measurements. Predictive tests of aerobic capacity (Tecumseh step test or 6 minute walk test) and strength (grip strength, grip endurance and arm strength), were graded as pass, fail or borderline. The direct task measurements were passed or failed. These included climbing a flight of stairs carrying a load, a rope haul (ERT only), and a hose roll out (ERT only).

NOTES:

A REVIEW OF THE FITNESS STANDARD FOR THE ROYAL NATIONAL LIFEBOAT INSTITUTION BOAT CREW.

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[1]Department of Sport and Exercise Sciences, University of Portsmouth, UK
[2]DGPFSS National Defence, Ottawa, Canada
Corresponding author: gemma.milligan@port.ac.uk

INTRODUCTION

A total of 2,692 individuals have passed the Royal National Lifeboat Institution fitness standard in four years with no adverse incidents to boat crew. Of these, 553 were assessed on the All-Weather lifeboat fitness standard; 999 were assessed on the Inshore Lifeboats fitness standard, and 1,140 individuals were assessed on both standards. The aim of the present review was to determine which tests were being failed.

METHODS

A sample of 748 (*n*=569 male; *n*=179 female) crew were randomly selected from those that had passed the fitness standard. The data of all of those that failed (*n*=12 male; *n*=7 female; *n*=3 unknown) were also examined. Age, height and mass were binned (grouped) to minimise error in the placement of the data of those that failed, and were reported as a percentage of those in their bin. Descriptive data were analysed to determine the possible cause of a failure.

RESULTS

Those that failed represented 0.8% of the 2,713 tested. Of the 22 failures, 17 subsequently passed, four remain on-going cases (it is unknown why). Data were categorised into the tests that individuals failed based on gender (Table 1). From Table 1 it is clear that females (mean[SD]; Age 30.7[13.3]yrs; Height 164.6[8.4]cm; Mass 77.0[23.4]kg) mostly failed the strength assessments, whilst males (Age 37.0[12.5]yrs; Height 182.5[6.3]cm; Mass 93.6[13.2]kg) failed the step test.

Table 1. The number of failures by fitness test. *NB one female failed both the grip strength and re-board*

Identifiers	Grip	Back Strength	Step Test	Anchor Pull	Re-board ILB	Re-tested Passed
Female	5	0	1	1	1	4
Male	0	0	12	0	0	10
Unknown	2	0	1	0	0	3

CONCLUSIONS

It would appear that there are trends for shorter, lighter females to fail the strength components, and taller, heavier males to fail the step test. What this review does not reveal is how close those

that failed a test were to passing it. Based on the finding that 17 of the failures subsequently passed the fitness test, it would seem reasonable to conclude that these initial failures were either due to factors unrelated to fitness, or were only narrow failures; therefore performance could be improved by training. Back strength was the only test that no one failed, however this is not a reason to remove it from the fitness standard; it could still be serving a purpose by encouraging crew to maintain functional capacity in this area. Back strength also predicts the ability to undertake a number of critical tasks.

NOTES:

TRIAGE: TAMING THE QUALITATIVE BEAST FOR QUANTITATIVE RESEARCHERS IN THE IDENTIFICATION OF TASKS ON WHICH TO BASE PHYSICAL EMPLOYMENT STANDARDS.

Michael Spivock, Daniel Théoret and Assane Niang
Directorate of Fitness, Canadian Forces, Canada
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INTRODUCTION

Developing operationally relevant physical employment standards typically involves a preliminary job familiarisation phase in which researchers determine the nature of the demands in the occupation under analysis. This phase can yield up to several hundred tasks, leaving researchers the challenge of reducing this list to a representative subset of common, essential tasks on which to base the eventual standard. The TRIAGE technique (Technique for Research of Information by Animation of a Group of Experts; Gervais & Pépin, 2002) has been adapted from the field of program evaluation in order to facilitate this process.

METHODS

Fundamental components of the original TRIAGE protocol have been modified to better suit the purposes of physical employment standard development and have been integrated into an electronic interface. The TRIAGE group session is based on participant interaction and accompanied by important visual support wherein tasks are moved through successive sections on a screen. Each individual task is moved from its starting location on the wall (the Dynamic Memory) through Combination/ Separation (where similar tasks are combined or complex tasks are broken into smaller components) and either to "Selection" (task retained as essential, common and physically demanding) or to the "Garbage" (task dismissed). Tasks where consensus is not achieved as to their common and essential nature at the outset can be placed in the "Fridge" and returned to at a later time when the group has had a chance to decide on other tasks and gain experience with the process. If at any time it is felt that the group assembled lacks the expertise to judge a certain task, this task is placed in the "Veto" column and submitted to an outside entity for analysis.

RESULTS

The tasks remaining in the Selection column at the end of the session represent the subset of common and essential tasks. No further transcription, qualitative coding, or transformation of the information is required, as would be the case with traditional focus groups. The tasks retained can subsequently be described in detail (in terms of pacing, duration, weights, distances, heights etc...) either by the same group of experts who selected them or by others more familiar with each task.

CONCLUSIONS

In conclusion, TRIAGE is a flexible method of obtaining expert consensus and has proven its adaptability to the context of physical employment standard development. Specific examples of the use of TRIAGE in a variety of physical employment standard development projects will be provided for illustrative purposes throughout this presentation.

REFERENCES: Gervais, M., and Pépin, G. (2002). *Eval. J. Aus.* 2(2): 45-49.

NOTES:

RE-EVALUATION OF THE PHYSICAL ABILITIES READINESS EVALUATION: PHASE I – TASK ANALYSIS.

Gregory S. Anderson[1], G. Girard[2], D. Plecas[3]
[1]Justice Institute of British Columbia, New Westminster, BC CANADA
[2]Fitness & Lifestyle, RCMP Learning and Development, Ottawa ON CANADA
[3]Criminology and Criminal Justice, University of the Fraser Valley, Abbotsford, BC CANADA
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INTRODUCTION

While police work is primarily sedentary, police officers are required to frequently engage in near maximal workloads for short periods of time during incidents of a critical nature. Critical incidents are often extremely physically challenging while the failure of officers to perform in such situations could clearly endanger themselves, their fellow officers, and the general public. The Physical Activities Requirement Evaluation (PARE) was designed as a bona fide occupational requirement (BFOR) evaluation in 1988 for the RCMP. To insure its present relevance to police work, this study performed a job-specific task analysis and linked the results to the discrete items in the present PARE.

METHODS

Questionnaires adapted from the POPAT re-validation study (Anderson and Plecas, 1999) were delivered to 142 general duty officers. Officers completed two questionnaires: one which asked them to describe the physical aspects of their job 'on average' (the Physical Work Record Survey Form) and another which asked them to describe the most physically demanding critical incident that they experienced in their most recent 12 months of work (the Critical Incident Survey Form).

The analysis of the Physical Work Record Survey Form is based on the responses of all 112 officers (82% response rate)**,** while the analysis of the Critical Incident Survey Form is based only on the responses of the 74 officers who had at least one year of service and who reported on an incident which occurred within the past year.

RESULTS

The present results are remarkably similar to those of previous findings (Anderson et al., 2001) demonstrating that police work has not changed significantly since the previous two studies. Only 3 of 18 ratings of frequency of activities differed between the present data and that of Anderson et al. (2001). Similar results are demonstrated for effort use in performing various physical activities. Comparison between activities performed by officers in controlling the problem demonstrated differences in only 3 of 18 tasks. The same can be said for the types of resistance used by subjects in critical incidents reported. These results provided general support for the use of the PARE as a BFOR evaluation tool.

CONCLUSIONS

Task analyses across police agencies in Canada have demonstrated a core set of bona fide occupational requirements that have remained stable over the past 12 years. The PARE remains relevant in today's policing world as a valid BFOR evaluation tool.

REFERENCES

Anderson, G.S., D.B. Plecas and T. Segger (2001). Police officer physical abilities testing: Re-validating a selection criterion. *Policing: An International Journal of Police Strategies & Management*. 24(1): 8-31, 2001.

NOTES:

A RECOMMENDED FITNESS STANDARD FOR THE MARITIME AND COASTGUARD AGENCY.

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INTRODUCTION

Her Majesty's Maritime and Coastguard Agency operate an Emergency Response service that is ready to respond to emergency calls 24-hours a day, 365 days a year for UK coast waters. Historically, the policy for trainee Coastguards was to undergo a six month training probation period, at the end of which the Sector Manager determined the suitability of the individual. There were no set guidelines to follow for determining suitability, and selection was based solely on a subjective opinion, thus a recommended minimum fitness standard was required.

METHODS

The following approach was adopted: Review the tasks requiring a significant physical fitness component (Task analysis); Determine the importance of the physically demanding tasks and identify those thought critical for success and safe work (Task assessment); Establish the method of best practice (technique) for undertaking the critical tasks; Establish and agree the minimum performance standard for the critical tasks (Task performance) when performed using the method of best practice; Assess the physical and physiological demands of these tasks (Task quantification); Design a simple-to-administer minimum fitness standard .

RESULTS

The critical tasks and fitness tests fell into three groups, these were: Group 1 (All Operations): a. Achieve a predicted maximum aerobic capacity score of 31mL.kg^{-1}.min^{-1} - based on the aerobic requirement to carry a stretcher. b. Pull a rope, with a resistance of 35kg, and maintain this load for 15s - based on manning the main line. c. Continuously lift a 4kg hammer 10 times above shoulder height. d. Carry a 19kg hand-held load 200m in 3min 45s allow 3min 45s rest, then carry a 25.5kg hand held load, 200m in 3min 45s. Group 2 (Rope Technicians) as Group 1, plus: successfully complete the current required competencies of rope technicians. Group 3 (Mud Technicians) as Group 1, plus: achieve a predicted maximum aerobic capacity score of 39mL.kg^{-1}.min^{-1} - based on the aerobic requirement to pull a stretcher across the mud at 0.8km.h^{-1}, equates to 200m being covered over mud in 15min, prior to performing a simulated mud rescue.

CONCLUSIONS

A modular fitness standard was recommended to the Maritime and Coastguard Agency, as individuals would fall into one of three groups. This standard included a predictive selection test for aerobic capacity (Tecumseh step test or 6 minute walk test) set at two levels dependant on the

group, individuals could achieve a grading of pass, fail or borderline. The other tests were all critical task simulations which could be passed or failed. Tests for all groups include; hammer raises, a simulated stretcher carry, a simulated rope pull. An additional critical task simulation of a mud rescue was required for Mud Technicians and Rope Technicians were required to pass additional rope based competencies.

NOTES:

OBSERVATIONS ON THE PREDICTIVE UTILITY OF HEART RATE AND MINUTE VENTILATION FOR ESTIMATING THE METABOLIC COST OF WORK.

Sean R. Notley, Hugh H.K. Fullagar, Simon D. Burley, Daniel S. Lee and Nigel A.S. Taylor
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INTRODUCTION

The direct measurement of the metabolic cost of working tasks can be difficult, and sometimes impossible. Fortunately, several cardiorespiratory variables respond in a predictable fashion to increments in work rate, such that they can serve as surrogate indices of energy expenditure. We have been exploring the utility of these measures for possible use in field-based predictions, firstly under laboratory conditions, and then within a series of occupational simulations.

METHODS

Under controlled laboratory conditions, 15 subjects completed three exercise modes within neutral and hot conditions: lower body (treadmill), upper body (arm cranking), whole body (rowing). Lower-body exercise was also performed whilst carrying a load (22 kg) in each thermal state. Within every condition, subjects completed four, 15-min bouts, each at a different intensity: rest, 20%, 40% and 60%. From these data, equations were derived to predict oxygen consumption using heart rate and minute ventilation. The utility of these predictions was evaluated during three field-based, fire-fighting simulations: 70-mm lateral hose drag (N=16), a hazmat simulation (N=16), a bush-fire hose drag (N=16). Oxygen consumption was measured and predicted from heart rate and minute ventilation using equations derived from lower-body, load-carriage exercise in the laboratory (neutral and hot), and differences between these values were evaluated.

RESULTS

In the laboratory, ventilatory predictions were consistently superior. However, heart rate and ventilatory predictions in the field did not differ significantly, except for the low-intensity activity (lateral hose drag), with heart rate predictions consistently over-estimating oxygen consumption to a greater extent (P>0.05): 1.13 ±0.11 versus 0.42 ±0.28 $L.min^{-1}$ (both significant). For the other simulations, the respective over-estimations were: hazmat: 0.42 ±0.39 (P>0.05) versus 0.61 ±0.31 (P<0.05); bush drag: 0.53 ±0.32 (P>0.05) versus 0.61 ±0.46 (P<0.05).

CONCLUSIONS

Whilst minute ventilation proved valid and ore precise under laboratory conditions, its utility within field-based occupational settings was somewhat limited. During two such scenarios, heart rate became the preferred index, and this change was associated with differences in work intensity between the laboratory and field trials. Intensities inducing deviations from the linear to

the alinear ventilatory responses (Owles point), require predictive data collection over this range. This did not occur. Had this occurred, and had individual-, mode- and state-specific predictions been derived, then superior predictive utility would have been observed for both surrogates.

Based on research funded by the Defence Science and Technology Organisation (Australia).

NOTES:

METABOLIC FITNESS AS A PREDICTOR OF INJURY RISK IN CONDITIONED MILITARY TRAINEES UNDERTAKING AN ARDUOUS FIELD TRAINING EXERCISE.

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INTRODUCTION

Musculoskeletal injuries reduce the ability for military forces to train new personnel. Metabolic fitness has been used to predict injury risk in new Australian Army trainees. The purpose of the present study was to examine the validity of using metabolic fitness to determine injury risk in conditioned military trainees completing an arduous field training exercise.

METHODS

Participants were officer trainees who had completed at least six months of full time military training. Metabolic fitness (VO2 max) was determined through use of retrospective 20m Progressive Shuttle Run data. Injury risk was determined through the use of retrospective injury data captured by a field medical officer during a 10-day arduous field training exercise. The metabolic fitness assessment was complete three days prior to the field training exercise. Ethical approval was granted by the Australian Defence Human Research Ethics Committee and the Bond University Human Research Ethics Committee.

RESULTS

In total, data from 140 military trainees from the Australian Regular Army (127 male, 13 female) were captured. The mean VO2 max for the injured group was 50.1ml.kg-1.min 1 (SD 4.5), and for the non-injured group 53.0ml.kg-1.min 1 (SD 3.4). This was statistically different, t=2.8 (p=0.006) irrespective of gender. The mean VO2 max was higher for males (53.1ml.kg-1.min-1, SD 3.2) than females (46.8ml.kg-1.min-1, SD 4.4) t =-6.6 (p=0.0001) and participants with a VO2 max below 1SD of the mean were three times more likely to be injured than those above 1SD from the mean (p=0.049).

CONCLUSIONS

The results of this study suggest that metabolic fitness as determined through a 20m Progressive Shuttle Run assessment is a valid predictor of injury risk for conditioned military trainees prior to undertaking an arduous field training exercise.

NOTES:

RE-EVALUATION OF THE PHYSICAL ABILITIES READINESS EVALUATION: PHASE II – DISCRETE ITEM ANALYSIS.

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[3]Criminology and Criminal Justice, University of the Fraser Valley, Abbotsford, BC CANADA
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INTRODUCTION

Organisations who wish to impose a bona fide occupational requirement are required to identify the most demanding and most representative tasks performed in the occupation, and determine the physiological requirements that are required for the successful completion of these tasks (Gledhill et al., 2001). People seeking employment in, or those already employed in the profession, should then be expected to exhibit these characteristics as they are related to the person's ability to successfully perform their expected job duties. To fully appreciate the elements of the Physical Abilities Requirement Evaluation (PARE) that are most related to the role of police officers in the field, the present study surveyed a group of subject matter experts, and the incumbents concerning the present elements embedded within the PARE, and potential changes that could be made to improve the extent to which the PARE reflected the true physical requirements of police work.

METHODS

This research project consisted of three distinct phases: 1. instrument development; 2. subject matter experts and instrument modification; and, 3. incumbent survey. Following instrument development, 20 subject matter experts (SMEs) completed the survey and their feedback was then used as a basis for discussion and revision of the instrument. Surveys were completed by SMEs at a meeting, while surveys were handed out to a representative sample of RCMP members across Canada immediately after they completed their PARE. There was a 96% response rate with 844 completed surveys being returned.

RESULTS

Results were compiled for each of the SME and regular member groups under three general categories - obstacle courses, push/pull, and weight lift and carry. Of the officers surveyed: 86.1 % report the obstacle course to be relevant or very relevant to their job duties and were supportive of each element embedded within the obstacle course; 84.5% reported the push and pull section to be relevant of very relevant, while 80.3% suggested the duration of the segment was relevant or very relevant; Data from the present study suggest that the lift and carry portion of the PARE is the least supported element by members and generated the most comments for change, however this element is not included in the timed portion of the course.

CONCLUSIONS

Present data from both SMEs and active members of the RCMP provides strong support for the present configuration in the PARE. While consideration should be given to the enhancement of the PARE, the current and previous task analysis do support the test in its actual format as being representative or very representative of police work in the 21st century.

REFERENCES

Gledhill, N., Jamnik, V.K. & Shaw, J (2001). Establishing a Bona Fide Occupational Requirement for physically demanding occupations. In Gledhill, N., Bonneau, J. & Salmon, A. (Eds.). *Proceedings of the National Forum on Bona Fide Occupational Requirements* (pp. 9-13). Toronto, Ontario: York University.

NOTES:

ESTIMATION OF THE PHYSICAL DEMAND OF THE ROYAL NEW ZEALAND NAVY FIRST AID/EEBD RUN.

Helen Kilding and Bryan P. Dobson
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INTRODUCTION

The current Royal New Zealand Navy (RNZN) fitness test is based on research conducted in 1998. Several limitations of this research have since been identified and the physical tasks that all seagoing personnel might be expected to perform have changed. The First Aid/Emergency Escape Breathing Device (EEBD) run is an emergency fire fighting task and has been identified as one of the physical tasks that all seagoing personnel are expected to be able to perform. The activity involves locating and extinguishing a fire in the lower deck and escaping back to the main deck having donned an EEBD. The aim of this study was to quantify the physical demand of this task.

METHODS

A sample of Junior Officer Common Training (JOCT; n = 27) and Team Leaders (TL; n = 16) course participants performed a timed EEBD run in pairs, following a period of theoretical and practical training. Basic firefighting rig and anti-flash hood and gloves were worn and a full and charged AFFF extinguisher carried. Heart rate (HR) was measured throughout the exercise and on completion, participants provided a Rating of Perceived Exertion (RPE). JOCT participants also performed a maximal Multi-Stage Fitness Test (MSFT) to predict VO_{2max} and HR_{max}.

RESULTS

Time to complete the EEBD run ranged from 3 min 37 s to 8 min 7 s (JOCT average 5:43; TL average 4:19). All times were within the 10 minute cut-off considered acceptable by training staff. Faster completion times for TLs were associated with higher average and peak HRs, and a one point higher RPE (4 v 3). Reasons for this may include increased familiarity with the task, higher motivation, and/or increased competitiveness. For JOCT individuals, peak heart rate averaged 76% HR_{max} and average intensity was 66% HR_{max}. This translates to an average %VO_{2max} of 45% (Swain *et al*., 1994). TLs were working at 80% of their age-predicted HR_{max} (66% VO_{2max}) but RPE scores were still low. Time to complete the EEBD run showed no correlation with predicted VO_{2max}.

CONCLUSIONS

The results of this basic analysis would suggest that the EEBD run is of low to moderate physical demand. Given the "complete/cannot complete" nature of the task; the inappropriateness of encouraging personnel to perform the task faster, due to safety concerns; and the lack of

correlation between EEBD time and predicted VO_{2max}, the use of a generic fitness test to reflect performance on the EEBD run is not recommended. Regular assessment of effective performance of this task (and others currently being confirmed) is recommended for all seagoing personnel, along with the annual/biannual assessment of the health-related fitness of all RNZN personnel.

REFERENCES

Swain, D. *et al*. (1994). *Med Sci Sports Ex.* 26: 112–116.

NOTES:

ON LEGALLY DEFENSIBLE PHYSICAL EMPLOYMENT STANDARDS.

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KEYNOTE PRESENTATION

Significant Canadian legal and human rights legislation have imposed strict criteria for developing applicant and incumbent physical fitness employment standards to qualify as a bona fide occupational requirement (BFOR). This is particularly important in those public safety occupations in which job completion is critical to the protection of life and property. The imposed criteria compel researchers and occupational stakeholders to ensure that the standards are validly linked to the critical physically demanding tasks of the occupation, and have necessitated the implementation of a systematic 12 step research development process - the BFOR Consensus Forum Template (Gledhill 2001). This template was applied to the development of physical fitness employment standards for prominent public safety occupations. The physiological characterization of the critical tasks in each occupation involved measurements on "safe and efficient" incumbent personnel while performing these tasks on-the-job and/or during in-field task simulations to determine the weights, heights, forces, distances, speeds, work/rest cycles and metabolic cost associated with performing the critical tasks. The essential forces and distances of each occupation were embodied into the resultant physical fitness test protocols. The incumbents who participated in the research were stratified by age, sex and work experience to ensure that the consequent job-related physical fitness standards were job criterion-based and not employee characteristics-based. Construct validity of each job-related physical fitness protocol was achieved by statistical comparison of the physiological demands while incumbent personnel were performing the critical on-the-job tasks to the demands while they were performing the test protocol. The measured minimum oxygen cost (mL·kg-1min-1) to perform each protocol was: 41.7 for Alberta police, 40.3 for Ontario police, 39.0 for correctional officers, 37.0 for nuclear emergency personnel, 42.5 for structural fire fighters and 37.0 for wildland fire fighters. The content validity of these protocols was confirmed by very high incumbent Likert Scale ratings ($\geq$ 6.0 on a 7-point scale), and the associated test-re-test interclass correlation coefficients ranged from .812 to .98. To satisfy the Supreme Court of Canada's Meiron Decision (SCCMD) requirement to "accommodate" individuals who may be adversely impacted by the test standard without imposing undue hardship on the employer" (1999), we demonstrated that familiarization opportunities, motivational coaching during test performance and job-specific physical fitness training improved test performance by 10%, 4% and 20% respectively, and therefore will serve to provide "de facto" accommodation to overcome adverse impact. The development of these public safety protocols demonstrates the application and effectiveness of the BFOR Consensus Forum Template for establishing bona fide physical fitness employment standards for public safety occupations in conformity with the SCCMD.

REFERENCES

Gledhill N, Bonneau J, Salmon A eds. (2001). Proceedings of the Consensus Forum on Establishing BONA FIDE Requirements for Physically Demanding Occupations, York University, Toronto, ON, Canada.

NOTES:

DEVELOPMENT OF A PRE-EMPLOYMENT FITNESS TEST FOR UNIVERSITY SECURITY OFFICERS.

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INTRODUCTION

Workplace fitness tests are often controversial and require justification on the basis of the workplace demands, however inappropriate fitness or recovery from injury predispose workers to increased risk of injury. University Security Officers (USOs) had been observed to experience a number of work-related injuries and there were no objective criteria for return to work status. In this project, the aims were to first determine the workplace demands of USOs and then develop a pre-employment and return to work physical fitness test.

METHODS

The work tasks of USOs were investigated by a questionnaire completed by 9 male USOs at the end of at least three shifts. Also USOs wore continuously recording heart rate monitors during those shifts as an indication of work demands. This information was then used to develop a pre-employment physical-fitness screening test.

RESULTS

The main work tasks involved walking and climbing stairs; USOs on cycle patrols spent most of that patrol cycling. High intensity lifting or locomotor tasks were seldom performed and were of short duration, but could not always be predicted. The fitness test consists of an assessment of body mass index and body composition; a stair climb during which heart rate is monitored; a treadmill-based progressive exercise test to exhaustion for assessment of aerobic fitness; and a 300m shuttle anaerobic test requiring high intensity running and turning.

CONCLUSIONS

A comprehensive understanding of the job demands was obtained and formed the basis of the range of activities included in the fitness test. The standards required were most difficult to establish and are modest but subject to ongoing review. Most importantly, they form objective criteria for assessment of return to work following injury.

NOTES:

TESTING OUR POLICE: HOW SAFE?

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INTRODUCTION

Law enforcement is predominantly very low intensity activity that could be interrupted by unpredictable and potentially dangerous bursts of strenuous physical exertion. A police officer's fitness and ability to complete key tasks needs to be preserved in preparation for those high stress moments, often critical to job performance, but paradoxically the physical activity required of a police officer is insufficient to maintain a suitable level of fitness. In 1986 the New Zealand Police introduced a Physical Competence Test (PCT) that all sworn staff must pass every 18 months. The test includes specific tasks that are individually challenging and cumulatively fatiguing, however, the NZ Police force and the society in which they operate have changed dramatically since the PCT's introduction 25 years ago. This study explored the physiological demands of the PCT, how these matched the physical demands of current frontline policing, and the perceived safety of the PCT.

METHODS

Seventy-one participants (44 male and 27 female) completed a running VO_{2max} test and then on separate occasions completed (1) a time specified (TS) PCT that was paced according to age and gender specific norms, (2) a maximal effort (MAX) PCT, and (3) a modified PCT at maximal effort. All participants completed the MAX PCT and forty five of those participants (25 male, 20 female) also completed the TS PCT and the modified PCT. Modifications to the PCT were made to better represent the physical demands of contemporary frontline policing, and to improve the safety of the test. Heart rate, VO_2 and post-exercise lactates were collected on all trials.

RESULTS

The New Zealand Police PCT is a high intensity circuit that introduces a relatively high level of cardiovascular stress. Participants exercised at near maximum functional capacity (average 98.47 ± 9.06 $\%VO_{2max}$; 94.47 ± 3.68 $\%HR_{max}$; post-exercise lactate 9.98 ± 0.35 mmol/l) when completing the test. Shortcomings in strength or technique extend the test duration and amplify physiological load. The difference between the MAX PCT and TS PCT times was significantly less for younger (<30 yr) participants, with this group also having to work at a higher proportion of their maximum functional capacity to achieve their target times than the older (>30 yr) participants. The physiological load and profile of the modified PCT was not significantly different from that of the TS PCT.

CONCLUSIONS

The PCT is a high intensity test. As such, the PCT is potentially hazardous for individuals with elevated cardiovascular disease risk profiles. The time allowances appear to favour older participants in terms of the relative effort required to achieve their target time. Results demonstrate that modifications to the PCT could be accommodated to improve its validity and safety without significantly altering physiological load.

NOTES:

CULTIVATING A HEALTHY AND RESILIENT WORKFORCE.

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The nature of pre-hospital care means that Paramedics can be exposed to occupational stress and traumatic events on a regular basis. In 2010, the Ambulance Service of NSW (Ambulance) set about an ambitious plan for promoting emotional resilience and improving awareness of employee mental health and suicide prevention within the Ambulance workforce. The Wellbeing Resilience Advisory Panel (WRAP) was established by the Ambulance Executive to oversee the strategic development and implementation of a range of employee wellbeing and mental health initiatives. This Panel is being supported by the establishment of a Working Group with representatives from across Ambulance and will include external specialists.

A number of dedicated training programs were developed, in collaboration with experts in the field of post traumatic mental health, which are designed to enhance the capacity of employee's to deal with the effects of traumatic stress as well as strengthening the capacity of the organisation to respond to concerns about individuals who may be at risk of self-harm or suicide. A key initiative was the development of the 'Promoting Employee Wellbeing and Mental Health' workshop which is designed to enhance the skills of frontline managers to deal with mental health issues as they arise. As part of Ambulance's commitment to employee health and wellbeing, a 'My Wellness Check' initiative has also been piloted across the organisation providing staff with an opportunity to meet with a psychologist and to monitor their own psychological wellbeing and to learn practical self-care techniques.

In addition, existing staff support services (e.g. Peer Support, Chaplaincy and Employee Assistance Program) have been enhanced to provide emotional support to individuals who have been impacted by exposure to traumatic events in the workplace.

In September 2009, a Health and Wellness Program was introduced into the Ambulance Service of NSW Death and Disability (State) Award consisting of a compulsory Health Assessment Program and a non-compulsory Support Program. Compulsory health assessments are required every three years for all operational Paramedics and operational managers utilising a specifically designed NSW Paramedic Health Standard. The purpose of the health assessment is to ensure Paramedics are fit to perform inherent physical and psychological requires of their job and to identify negative lifestyle habits, risks and provide management of medical conditions. The Support Program encourages staff to improve or maintain their overall health and fitness. These behaviour modification programs aim at increasing work capacity and productivity, reducing injury and disease and satisfying personal health outcomes.

The purpose of this presentation is to chart the journey that the Ambulance Service of NSW has taken in this important area of staff wellbeing and support and to showcase a range of initiatives which have been developed to cultivate a healthy and resilient workforce.

NOTES:

USE OF THE BOOKMARK PROCEDURE TO SET A PERFORMANCE STANDARD FOR THE CANADIAN FORCES FIREFIGHTER FITNESS MAINTENANCE TEST.

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INTRODUCTION

Canadian Forces (CF) firefighters complete an annual physical fitness test to prove fitness for duty. The CF FFPFMT consists of 10 job-related tasks organized in a standardized circuit. The test is considered a valid sample of the work reasonably expected of a single firefighter during an emergency response. Fitness for duty is inferred from the overall time taken to complete the circuit. The purpose of this research was to develop a new performance standard that, consistent with Canadian Human Rights law, represented the slowest acceptable rate of work to complete the test.

METHODS

An expert panel of 25 senior firefighters (experience 15 ±9.9 yr.), in supervisory positions in the CF fire service, who had previously taken the test, set the standard using a modified Bookmark Procedure. Following a discussion of the test, and definitions of acceptable, unacceptable, and minimally acceptable physical work capacity, each judge independently viewed a DVD containing an ordered series of 9 work samples showing an actor completing the test at paces ranging from 6:40 to 9:20 minutes in 20 second intervals. The fastest time was consistent with the average test time for all CF firefighters. All tasks were completed correctly, but proportionately slower between work samples 1 and 9. After viewing all 9 work samples, each judge inserted a "bookmark" between the last work sample where the work rate was judged to be minimally acceptable and the first work sample where the work rate was judged as unacceptable. Subsequently, the results of the first round of judgements were presented to the panel, and a discussion followed where judges freely discussed the reasoning for their decisions. This was followed by a second round of judgments. The results of the second round were again presented and discussed. A third and final round was then completed.

RESULTS AND CONCLUSIONS

Each "round" of judgments led to greater consensus among the judges. Whereas the standard calculated from the mean of the judges' evaluations was essentially the same (7:55) across the three rounds, the standard error of the mean (SEM) systematically decreased (5.50 to 2.89 s). In the present case, it is justifiable to set the standard at a fixed point, and then to build uncertainty around the standard given that there was still some variation among the panel members at the end of Round 3. Therefore, in keeping with the Bookmark Procedure, it was recommended that the standard be set at 7:55 (Round 3 result) and that the upper limit of the 95% confidence interval be

added to this value to account for the uncertainty just described. Firefighters who complete the TEST in: (1) 7:55 or less are considered to have adequate work capacity to complete first response firefighting activities. *Ready to continue*; (2) over 8:01 are considered to have less than adequate work capacity to complete first response firefighting activities. *Corrective action needed*; and (3) over 7:55 up to 8:01 are considered to either have or not have adequate work capacity to complete first response firefighting activities. *No corrective action but re-take test*.

NOTES:

CONTEMPORARY PHYSICAL AND MEDICAL STANDARDS FOR FIRE & RESCUE NSW.

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KEYNOTE PRESENTATION

Fire & Rescue NSW (FRNSW) is one of the world's largest urban fire and rescue services, and the largest and busiest in Australia. The physical capability and psychological resilience of firefighters is critical to safely achieving the organisations overriding purposes of enhancing community safety, quality of life and public confidence by minimising the effects of hazards and emergencies on the population it serves (7.2 M), and on the property, environment and economy of NSW.

The equipment for, and techniques of contemporary fire fighting have evolved over time, along with the demands of this essential job. Indeed, the exposure of firefighters to stresses associated with material handling, load carriage (including personal protective equipment), operating in confined spaces and hot environments, are known to impose unique physical and physiological demands upon firefighters. These demands often lead to injuries, which are skewed towards older firefighters. For instance, male firefighters >40-years old represent 61% of the workforce, but suffer 75% of the sprain and strain injuries and account for about 90% of the lost work time (1998-2007). The sudden changes in work tempo from rest to high intensity work, place significant demands upon the cardiovascular system. Thus, firefighters are 14 times more likely than similarly aged members of the community to suffer sudden cardiac death following an alarm, and 136 times more likely after strenuous fire fighting. This too is more evident in older individuals.

To maximise operational readiness, and the health and safety of the workforce, FRNSW has engaged appropriate occupational medicine and scientific experts to ensure that its medical and physiological employment standards reflect this evolution. The aim of this research is two-fold. Firstly, it seeks to facilitate the identification and recruitment of individuals who are medically and physiologically capable of tolerating the work-related stress of fire fighting, without succumbing to injury or endangering colleagues or community members. Secondly, it is aimed at identifying individuals who are ill-suited to fire fighting, and who would be prone to medical complications or injuries when performing the more demanding aspect of fire fighting.

Once in the workforce, FRNSW promotes the maintenance of a functional and medical status consistent with these standards. This requires extensive support programmes supported by

Exercise Scientists within FRNSW, and other allied health professionals. Additionally, FRNSW has established robust support programmes for the implementation of mandatory standards.

NOTES:

THE PHYSICALLY DEMANDING AND CRITICAL TASKS PERFORMED BY PERMANENT AND RETAINED FIREFIGHTERS.

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INTRODUCTION

During fire emergencies and rescue operations, firefighters experience a high-level of physical stress, and are expected to possess the physiological attributes necessary to tolerate these demands. Thus, recruitment practises leading to the identification of stress-resistant individuals would increase unit capability and minimise the risk of firefighter injury. One strategy for this is to develop valid, physiological employment standards. In this, and two subsequent presentations, the research stages leading to the development of predictive screening tools for firefighters will be described. The first phase in achieving this outcome was to conduct a comprehensive review of the physical demands of fire fighting, and this is focus of our first communication.

METHODS

To identify the essential tasks of fire fighting, a four-stage process was undertaken. Firstly, researchers were familiarised with the trade, visiting 11 Fire Stations and interviewing 106 permanent and retained firefighters. Secondly, many tasks were demonstrated to the researchers, who performed preliminary movement and task analyses. Thirdly, in consultation with senior subject-matter experts, 31 tasks were identified for further investigation. Finally, 1,011 firefighters (717 permanent, 272 retained, 22 incomplete) participated in a confidential survey concerning task importance, frequency, duration and difficulty, thereby facilitating identification of the essential trade tasks.

RESULTS AND CONCLUSIONS

Since the next phase involved quantifying the demands of these tasks, then it would be inefficient to study all 31 tasks. A five-stage filtration process was therefore applied. (1) Tasks with a subjective effort rating below the two calibration tasks were eliminated. (2) If a sub-threshold task was performed more frequently or was more important than the calibration tasks, or was identified by >20% of firefighters to cause a physical limitation, then it was retained. (3) Where tasks were sufficiently similar, the more difficult task was retained. (4) Two-person, skilled tasks introduce uncontrolled performance variability, reducing measurement precision. Most were eliminated, unless the task was unskilled or individual contributions could be easily measured. (5) Tasks that were difficult to define, due to their nature or duration, were hard to reduce into discrete and reproducible tasks. These too were excluded. The resulting 15 tasks were: rolling out hoses, locating and connecting to a hydrant, coupling hoses, dragging charged hoses, stair climb with a hose, prolonged use of hoses (38 and 70 mm), fire attack, ladder use, firefighter rescue,

using spreaders and shears, using a sledge hammer to gain entry, carrying a ventilation fan (stairs), hazmat operations and dragging charged hoses (bush: hilly and uneven terrain). These tasks represent a valid subset of physically demanding activities performed by firefighters in metropolitan and regional NSW.

This research was funded by Fire & Rescue New South Wales (Australia).

NOTES:

THE PHYSIOLOGICAL AND PHYSICAL DEMANDS OF CONTEMPORARY FIRE FIGHTING: SIMULATIONS PERFORMED BY OPERATIONAL FIREFIGHTERS.

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INTRODUCTION

In the preceding communication, 15 tasks, representing a valid subset of the physically demanding activities performed firefighters in metropolitan and regional NSW, were identified. The second phase in developing legally defensible physiological employment standards was to quantify and evaluate the physiological demands of these tasks, when performed by firefighters.

METHODS

Experienced, operational firefighters (*N*=51) with a range of skills, ages, body sizes and fitness levels were recruited (37.3 y [range 23-57]; operational experience 9.2 y [range 1-29]; mass 55.3-113.6 kg); female representation reflected the workforce. Simulations were designed by subject-matter experts, then set out and controlled by Training Officers. Firefighters participated as platoons, under direction of their Station Officer, ensuring realistic operational efficiency and tempo. All simulations used contemporary tools and equipment, with firefighters wearing the appropriate personal protective clothing, equipment and breathing apparatus. The following variables were monitored continuously: heart rate, oxygen consumption, minute ventilation, tidal volume and breathing frequency. Tasks were also analysed using still and video photography.

RESULTS AND CONCLUSIONS

Simulation durations ranged from 1.14-52.33 min, with eight being <5 min, two were 5-10 min, one was 10-15 min and five tasks lasted >15 min. Since the next phase involved developing a subset of screening tests that could represent the observed tasks and physiological strain, algorithms were used to separate strength- and endurance-related activities, and to classify tasks according to the body region involved, primary movement patterns and loads carried. No tasks were unloaded endurance activities. No strength or muscular-endurance activities involved lifting and placing, or twisting and turning. Only 30% of these tasks were deemed to be endurance-dependent activities (cardiorespiratory or muscular). The 15 tasks were dominated by actions involving the pushing, pulling or dragging of objects >20 kg. The algorithm also culled the least demanding activities, and grouped tasks sharing common movements and physiological attributes, thereby identifying other activities that could assess these capacities under more stressful conditions. It was evident that these essential fire-fighting tasks primarily involved holding and carrying actions, and were largely reliant upon upper-body strength or muscular endurance. Through this analysis, identification of the criterion fire-fighting tasks was facilitated, providing a

valid prescription for designing recruit screening tests. This is the focus of the next presentation.

This research was funded by Fire & Rescue New South Wales (Australia).

NOTES:

RECOMMENDED SCREENING TESTS FOR CONTEMPORARY FIREFIGHTERS.

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INTRODUCTION

The previous presentation described the detailed analysis of 15 essential fire-fighting tasks, leading to the generation of a list of criterion tasks and a valid prescription for the design of physiological screening tests for potential firefighters. The third phase of this research project, and the focus of this communication, was centred upon the development of these screening tests.

METHODS

The criterion tasks were carefully examined. Each task was classified into a movement category (Table), and evaluated against exclusion criteria: low metabolic demand, movement duplication and possible substitution tasks. Six operational constraints were considered: environmental, equipment, operating posture, structures and surfaces used during ambulatory and load-carriage tasks, load masses, and the existence of possible generic lifting and locomotor activities.

Table: Criterion task movement classifications.

Class	Class descriptions	Criterion tasks
1	Single-sided carrying tasks	Hazmat task
		Rolling out hose (70 mm)
		Locating and connecting to hydrant
		Drag charged 70-mm hose (lateral)
		Ladder carriage (10.5 m)
		Prolonged use of hose (38 mm)
		Prolonged use of hose (70 mm)
		Stair climb with ventilation fan
2	Overhead push and holding tasks	Motor-vehicle rescue
		Ladder under-run (10.5 m)
		Using a sledge axe to gain entry
3	Cardiorespiratory dragging tasks	Fire attack
		Dragging charged hose (38 mm)
4	Crucial strength tasks	Stair climb with charged hose
		Firefighter rescue

RESULTS AND CONCLUSIONS

From this distillation, it was proposed that the screening tests be conducted as an uninterrupted sequence of activities (circuit) involving: single-sided carriage task(s), holding task(s), hose drag, fire attack and firefighter rescue. It was recommended that satisfactory performance be

determined from the time required to complete the circuit, with the standard being dependent upon the minimal acceptable work tempo for these tasks, as performed by existing operational firefighters.

This research was funded by Fire & Rescue New South Wales (Australia).

NOTES:

PHYSIOLOGICAL AND MEDICAL CONSIDERATIONS WITHIN MIXED-GENDER MILITARY UNITS.

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KEYNOTE PRESENTATION

Anthropometric and physiological factors disadvantage female soldiers in most aspects of physical performance. Aerobic fitness of women is lower than of the average men. Thus, women have a lower overall work capacity and, therefore, exert themselves more than men to achieve the same output. The lower weight and fat free mass and the higher body fat of women are associated with lower muscle strength and endurance, and disadvantage them, compared to men, in carrying out military tasks, e.g. lifting, carrying weights, and marching with a load. Working at a higher percentage of their maximal capacity to achieve the same levels of performance as men, women fatigue earlier, and they are at increased risk of over-use injuries. Smaller size and lower bone density also predispose women to a higher incidence of stress fractures. Noteworthy, training narrows the gaps in fitness, but still difference between the genders exists following basic training.

Nevertheless, integrating females into military professions, in mixed-gender units, is doable in most cases with the exception of those 'close combat roles', mainly because of the extreme physical demands that are beyond the female soldier capacity of physiological adaptability. Once the gender differences are recognized and doctrine of operation is adjusted accordingly, female soldiers in mixed-gender units can meet the physical standards for the assigned missions and no direct evidence exists that women have a negative impact on combat effectiveness.

The core of the present review is military oriented. Gender-related physiological differences, in view of their potential effects on military related performance and readiness will be discussed. This will be based on relevant applied physiology studies and on worldwide attempts to integrate females into traditionally male-dominated combat positions.

NOTES:

BODY FAT AND PHYSICAL ACTIVITY

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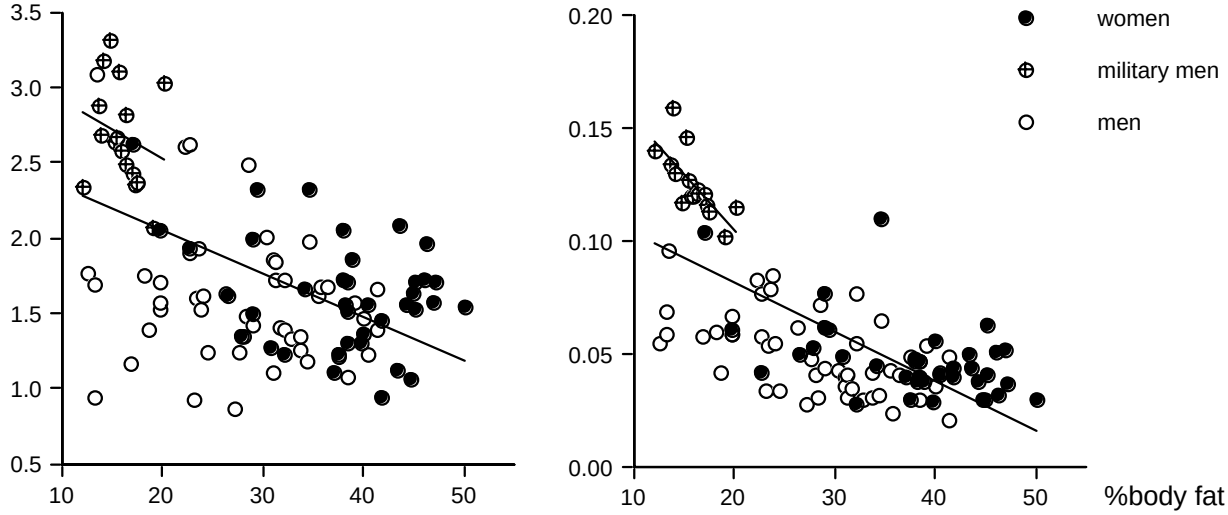
INTRODUCTION

Overweight, especially excess body fat negatively affects physical performance. The present study examined the relation between body fat and body movement and activity energy expenditure in normal weight, overweight and obese subjects and in men during military training.

METHODS

Subjects were 38 women, body fat 17-50%, 49 men, body fat 13-41%, and 16 military men, body fat 12-20%. Body movement and activity energy expenditure were assessed over two-week intervals with, respectively, a validated tri-axial accelerometer (www.directlife.philips.com) and with doubly labelled water. Body fat was derived from body weight and total body water as assessed with Deuterium dilution.

RESULTS



Body movement (left, Mcounts/d) and activity energy expenditure (right, MJ/kg), plotted as a function of body fat, with the linear regression lines separate for women and men and for military men.

CONCLUSIONS

Excess body fat limits body movement and exercise performance and/or vice versa.

REFERENCES
Westerterp KR, Rietjens GJWM, Wouters L.
http://ftp.rta.nato.int/public/PubFullText/RTO/MP/RTO-MP-HFM-181/MP-HFM-181-12.doc

NOTES:

A COMMENTARY ON ENDURANCE FITNESS STANDARDS APPLIED TO OCCUPATIONS THAT INVOLVE LOAD CARRIAGE AND MANUAL HANDLING.

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INTRODUCTION

Cardiorespiratory (endurance) fitness standards for physically demanding occupations are often referenced to a measured or predicted peak aerobic power (peak oxygen consumption). Most commonly, this is expressed in the form of a mass-normalised or specific power ($mL.kg^{-1}.min^{-1}$), which is then predicted from a maximal test (*e.g.* shuttle-run test) performed in sports attire. In this communication, the validity of this approach is examined, with respect to its application to endurance fitness standards for occupations that involve load carriage and manual handling, and with a view to removing mass bias from physiological employment standards.

METHODS

A good working example for this discussion is the fitness standard used by most fire-fighting organisations ($45\ mL.kg^{-1}.min^{-1}$), which is invariable predicted as described above. Notwithstanding its popular use, this overall approach is frequently inappropriate for the following reasons. (1) A one-to-one relationship between oxygen consumption and body mass does not exist. (2) Linear (arithmetic) normalisation fails to fully account for the inter-individual variability in oxygen consumption. (3) The coefficient of variation for oxygen consumption often exceeds that for body mass. (4) There is a positive relationship between the peak absolute oxygen consumption and body mass, but a negative relationship between peak specific oxygen consumption and mass. (5) The affect of these artefacts increases as individuals approach body-size extremes. (6) Normalisation must reflect total mass, including protective clothing and equipment masses, otherwise the standard will be artificially inflated. (7) The fitness standard should be derive as a power ($mL.kg^{-0.67}.min^{-1}$), and not as a linear function. This will ensure that inter-individual variations in the masses of those investigated were not responsible for determining the employment standard. (8) Unloaded endurance tests are unreliable screening methods for occupations in which load carriage is an integral requirement, since absolute oxygen cost changes is proportional to the specific load (5% increase in relative load produces a 5% elevation in oxygen consumption). Thus, constant loads carried by workers of different masses, represent a greater metabolic demand for lighter individuals.

CONCLUSIONS

If one accepts these points, then one arrives at two conclusions. Firstly, the minimal endurance standard for firefighters ($45\ mL.kg^{-1}.min^{-1}$) may not have been correctly derived, and it may even be artificially inflated. Secondly, it is quite possibly invalid to use an unloaded endurance test to

evaluate this physiological capacity for workers in occupations that involve load carriage and manual handling.

Based on research funded by Fire & Rescue New South Wales (Australia).

NOTES:

WHY DO WE BREAK MILITARY PERSONNEL?

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KEYNOTE PRESENTATION

Injury rates in military populations are a concern for all western volunteer Armies. With a diminishing pool of fit recruits, reducing attrition during recruit training is essential to maintain entry numbers. For trained soldiers, reducing the burden of injury reduces the cost of premature medical separation[1], and the attendant loss of experience and capability.

There are a number of factors that influence injuries in recruits. The best available evidence shows that low levels of aerobic fitness at entry strongly correlate with the risk of injury during training[2]. Injury rates for women are twice that for men during recruit training, but when injury rates are adjusted for aerobic fitness the gender difference is no longer significant[3]. But the fact remains that most women enter recruit with significantly lower levels of aerobic fitness than males, due in part to the lower haemoglobin levels that result from menstruation.

Injuries in trained soldiers are also a problem. Previous injury is a consistently identified risk factor for subsequent injury[4]. This most likely represents incomplete rehabilitation from injury, with pressure to return to duty as soon as possible. Another factor in trained soldiers is the culture of "working through the pain". This leads to the phenomenon of late presentation of injury when it is more likely to be severe, often with the presence of secondary co-morbidity which can confuse the diagnostic process.

Primary prevention strategies have demonstrated some success, but require comprehensive injury surveillance and dedicated monitoring and evaluation of the results[5]. The Australian Defence Injury Prevention program demonstrated it's effectiveness during its brief existence.
Secondary prevention is perhaps more important, as the adequate recovery from injury is essential if re-injury is to be avoided. Traditional measures of fitness to return to duty have been the ability to pass the basic fitness test/assessment.. The Australian Physical Employment standards offer the prospect of job and task related physical standards that can be incorporated into physical reconditioning programs.

The high demands of military training and deployment place great stress on the bodies of soldiers. Both primary and secondary prevention efforts are required to reduce this burden on military forces, especially in an era of diminished recruit populations and falling Defence budgets.

REFERENCES

1. Rudzki S.J. The Cost of Injury to the Australian Army. PhD Thesis, ANU 2009.
2. Pope RP, Herbert R, Kirwan JD, Graham BJ. Predicting attrition in basic military training.Mil Med. 1999 Oct;164(10):710-4.
3. Niebuhr DW, Scott CT, Li Y, Bedno SA, Han W, Powers TE. Preaccession fitness and body composition as predictors of attrition in U.S. Army recruits. Mil Med. 2009 Jul;174(7):695-701.
4. Van Mechelen W. Running Injuries: A review of the epidemiological literature. Sports Medicine 14 (5): 320-335, 1992.
5. Pope RP. Injury surveillance and systematic investigation identify a rubber matting hazard for anterior cruciate ligament rupture on an obstacle course. Mil Med. 2002 Apr;167(4):359-62.

NOTES:

BODY ARMOUR: A PROBLEM WITH THE EQUIPMENT OR THE WEARER?

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INTRODUCTION

Law enforcement officers have traditionally worn and carried equipment required for their protection and the discharge of their duties. Officers wearing stab resistant body armour (SRBA) claim it restricts their functional mobility and negatively affects their physical performance. Given that failure to complete critical tasks in police work could have potentially fatal consequences for police officers, their work colleagues, and the public they serve, this research sought to explore the impact of such equipment. Further, since law enforcement workers inevitably encompass diverse job roles and physical characteristics, an important question was whether individual factors such as age, body size (BMI), and fitness level influenced the effect of SRBA on performance.

METHODS

Male participants (n = 52, 37 ± 9.2 yr, 180.7 ± 6.1 cm, 90.2 ± 11.6 kg, VO_{2max} 50 ± 8.5 ml/kg/min, body mass index (BMI) 27.6 ± 3.1, mean ± SD) completed a running VO_{2max} test and task familiarisation. Two experimental sessions were completed ($\geq$4 days in between) in a randomized counterbalanced order, one while wearing SRBA and appointments (loaded) and one without additional load (unloaded). During each session, participants completed 10 performance tasks based on selected police task elements: a timed balance task, an acceleration task that simulated exiting a vehicle, chin-ups, a series of drop jumps (safe vs. distracted on landing) and vertical jumps, a grappling task, a mobility task, and a 5-min treadmill run (zero-incline at 13 $km{\cdot}hr^{-1}$, running start).

RESULTS

There was a significant decrease in performance during all tasks with loading ($p < 0.001$). Mean performance decreases ranged from 13-42% while loaded, depending on the task, with further decreases of 6-16% noted after the 5-min run. Participants had greater physiological cost (↑%HR_{max}, ↑%VO_{2max}, ↑RER) and perceptual effort (↑RPE) during the 5-min run ($p < 0.001$). Those carrying larger relative load were more negatively affected during the balance, chin-ups, drop jumps and 5-min run ($p < 0.05$). The more habituated participants' only performed better during the balance, acceleration, jump height ($p < 0.05$). Covariate analysis showed that a combination of increasing age and BMI, and decreasing VO_{2max} may increase the relative impact of SRBA in some tasks, however, due to interacting effects, the impact of participant characteristics remains on-going.

CONCLUSIONS

Wearing SRBA and appointments significantly reduced performance during key task elements and resulted in greater physiological effort, which could have implications for optimal function in the working environment. Our results demonstrate that there is potential for earlier onset of fatigue and performance deficit with individuals carrying a larger relative additional weight, and those with lower cardiovascular fitness and increased body size.

NOTES:

THE OPERATIONAL LOAD CARRIAGE CONTEXT OF THE AUSTRALIAN ARMY SOLDIER.

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INTRODUCTION

Military soldiers are required to carry loads as part of their occupation. These loads have led to injuries and even mortalities on the battlefield (Orr *et al*., 2011). Recent evidence suggests that the absolute loads carried by Australian Army soldiers are increasing (Orr *et al*., 2010). The intent of this study was to investigate the loads carried by Australian Regular Army soldiers on operations and the contexts in which these loads are carried.

METHODS

Load carriage data were collected through an online questionnaire from experienced Australian Army soldiers representing Combat Arms, Combat Support Arms and Combat Service Support Corps. Captured survey data were triangulated against open-source operational information. Ethical approval was granted by the Australian Defence Human Research Ethics and University of Queensland Behavioural and Social Sciences Ethical Review Committees.

RESULTS

A total of 301 respondent reports were collected. Grouped data revealed soldiers reportedly carrying a mean load of 47.7 kg or 56% of respondents' mean body weight. The differences in operational loads, both absolute and relative, carried between corps were significant with Combat Arms Corps carrying heavier loads than Combat Service Support Corps. Female soldiers (11% of responses) reported carrying significantly lighter *absolute* loads (M=26.4 kg) than their male counterparts (M=39.0 kg) although no significant differences were found in *relative* loading (M=43% BW, M=47% respectively). The lightest and heaviest 20% of male respondents carried similar *absolute* loads resulting in a difference in relative loads that approached significance. Corps reported performing different tasks while carrying loads. These different tasks were associated with different loads.

CONCLUSIONS

The loads carried by Australian Army soldiers on operations varies between corps as do the contexts in which these loads are carried. While some individual differences (gender and body weight) in load carriage (absolute or relative) requirements may exist, these findings highlight the potential benefits of task and trade specific physical employment standards.

REFERENCES

Orr, R., Pope, R., Johnston, V., & Coyle, J. (2011). Load carriage and its force impact, *Australian Defence Journal,* 185, 52-63.

Orr, R. (2010). The history of the soldier's load, *Australian Army Journal, vii*(2), 67-88.

NOTES:

THE ROLE OF PRE EMPLOYMENT ASSESSMENTS IN A MULTIFACETED APPROACH TO INJURY PREVENTION IN AN EMERGENCY SERVICE – A FIFTEEN YEAR LONGITUDINAL PERSPECTIVE

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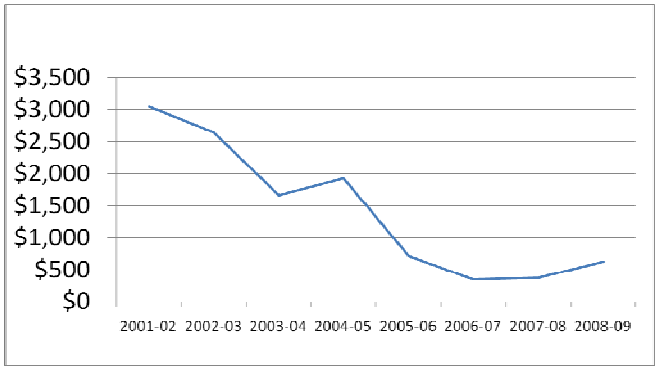
INTRODUCTION

This paper will present the historical process, current practices and the outcomes that have been achieved in the area of injury prevention by an emergency services organisation through the involvement of occupational health professionals as part of a multifaceted injury prevention program. This commenced in the late 1990's with a broad ranging evaluation of the manual handling and employment practices within the South Australian Ambulance Service at that time. Subsequent implementation of pre employment functional capacity evaluations and development of a train the trainer manual handling training program have affected injury and rehabilitation outcome statistics.

METHODS

Pre-employment functional capacity evaluation criteria have been based on measurements of the significant job demands in this work environment. Assessments have been modified over time to accommodate for changing equipment and work demands. All prospective South Australian ambulance service paramedics, including the Special Operations Team, now undertake a pre-employment assessment.

RESULTS



South Australian Ambulance Service: total costs from Manual Task injuries per SAAS employee

Injury data collated by SAAS indicates that the cost from Manual Task injuries has significantly decreased as a result of the multi-faceted approach. It is acknowledged that pre employment functional capacity evaluations are not solely responsible for these changes, with equipment improvements, ongoing training programs for employees and injury management strategies.

CONCLUSIONS

Pre employment functional capacity evaluations have contributed significantly to reducing the frequency and cost of injuries within a high risk industry.

NOTES:

PRE-EMPLOYMENT FUNCTIONAL ASSESSMENTS PREDICT MUSCULOSKELETAL INJURY RISK IN HEALTHY MALE COAL MINE WORKERS.

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INTRODUCTION

Sprains and strains continue to account for the largest proportion of workplace injuries in developed countries. Despite the scarcity of published validity studies in healthy workers, functional testing is being increasingly adopted as a predictor of workplace injury risk. The objective of this study was to determine if job-specific JobFit System Pre-Employment Functional Assessments (PEFA) predict musculoskeletal injury risk in healthy male coal miners.

METHODS

Participants in this prospective cohort study were recruited from an Australian coal mine between 2002 and 2009. At baseline, participants were screened with a job-specific JobFit System PEFA, and scores were dichotomised into PEFA 1 if they met the job demands and PEFA>1 if they did not. Injury data was obtained from the company's database and injuries were classified according to body location, severity and mechanism. The relationship between PEFA score and time to injury was analysed using Cox proportional hazards regression with adjustments for department. An interaction with time was identified and Hazard Ratios were calculated for 0 to 1.3 years and 1.3 to 6 years separately. The area under the receiver operator curve (AUC) was calculated to estimate the predictive ability of the PEFA to discriminate between participants with and without injury.

RESULTS

Six hundred participants (median age 37 years, range 17.0 to 62.6 years) participated in a job-specific JobFit System PEFA, with 427 (71%) scoring PEFA 1. The median follow-up time was 2 years (interquartile range 1.2 to 4.0). A total of 121 workers (20.2%) reported an injury and 29 workers (4.8%) reported a back injury associated with manual handling. Statistically significant differences were found between PEFA groups in time to injury over the longer term for all injury types: any injury (Hazard Ratio [HR]=2.3, 95% confidence interval [CI] 1.4 to 3.9), manual handing injury (HR=3.3, CI 1.6 to 7.2), any back injury (HR=3.3, CI 1.6 to 6.6), back injuries from (HR=5.8, CI 2.0 to 16.7). These relationships remained significant after adjustment for confounders. Moderate levels of the predictive ability of the PEFA were demonstrated over the longer term, with an acceptable predictive ability of the PEFA for back injuries from manual handling confirmed with an AUC value of 0.73 (CI 0.61 to 0.86).

CONCLUSIONS

The results of this study demonstrate that when using a job-specific JobFit System PEFA, the risk of musculoskeletal injury, particularly back injury associated with manual handling, is higher for workers who do not demonstrate the capacity to meet the inherent requirements of their job.

NOTES:

PHYSIOLOGICAL CHALLENGES AND CONSEQUENCES ENCOUNTERED DURING INTERNATIONAL MILITARY DEPLOYMENTS.

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INVITED KEYNOTE PRESENTATION

Modern international military deployments in austere environments (*i.e*. Iraq and Afghanistan) place significant physiological demands on Soldier physiology. Significant physiological challenges exist: environmental extremes (heat, cold, and altitude), environmental exposure hazards (*i.e* burn pits, etc.), rigors of external load carriage, maintenance of physical fitness and body composition, medical illnesses and musculoskeletal injuries, and the signature injuries of the current conflicts (traumatic brain injuries and post traumatic stress disorder). Unfortunately, to date there is very little published research and no comprehensive reviews on the physiological effects of deployments. This paper will overview what is currently known with regard to the challenges and consequences from deployments. Summary findings include: (1) environmental insults come from both terrestrial extremes and pollutant exposure, (2) load carriage continues to tax the physical capacities of the Soldier, (3) aerobic capacity declines while muscle strength, power and endurance appear to be maintained, (4) the majority of injuries come from musculoskeletal injuries, and (5) post-deployment concerns linger for traumatic brain injury and post-traumatic stress disorder. A full understanding of these responses will assist in identifying the most effective risk mitigation strategies to ensure deployment readiness.

NOTES:

RELIABILITY OF A BATTERY OF SOLDIERING TASK TESTS.

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INTRODUCTION

Soldiers often perform physically demanding tasks, such as materials handling, load carriage, and battlefield maneuvers. However, the U.S. Army does not currently assess Soldiers' ability to perform such tasks. Therefore, the purpose of this study was to determine the reliability of a test battery designed to assess soldiering task performance.

METHODS

Thirty-three enlisted Soldiers (31 men and 2 women; 23 ± 3 y; 1.75 ± 0.08 m; 81.4 ± 12.8 kg) completed a battery of soldiering task tests on four occasions, each separated by at least one week. The battery consisted of the following tests, in order: 1) 30-m grenade throw for accuracy; 2) running long jump while wearing a 20.5-kg fighting load; 3) one-repetition maximum box lift performed from the ground to the height of 155 cm; and 4) 3.2-km load carriage time-trial while wearing a 33-kg approach load. Raw scores were examined to determine the reliability of each individual test. Additionally, raw scores were converted to z-scores and then summed across the four tests to generate a composite score that reflected each Soldier's overall performance on the test battery for a given trial.

RESULTS

Repeated measures analysis of variance indicated significant ($p < 0.05$) improvements in performance between consecutive trials for the long jump (Trial 4 > Trial 3 > Trial 2), box lift (Trial 3 > Trial 2 > Trial 1), and load carriage time (Trial 2 < Trial 1), while the grenade throw demonstrated non-significant changes. The intraclass correlation coefficients for the grenade throw, long jump, box lift, and load carriage tests were 0.88, 0.88, 0.90, and 0.85, respectively; and the standard errors of measurement (% of mean) were 1.10 m (26%), 0.12 m (5%), 4 kg (6%), and 1.3 min (5%), respectively. For the composite score, the intraclass correlation coefficient was 0.93.

CONCLUSIONS

Significant learning effects existed, indicating that this test battery requires familiarization before a stable value is obtained. The long jump, box lift, and load carriage tests demonstrated excellent reliability (SEM = 5-6% of mean value), while the grenade throw test demonstrated marginal reliability (SEM = 26% of mean value). Overall performance on the test battery was relatively

reliable (ICC of composite score = 0.93). We conclude that this soldiering task test battery can be used as a reliable assessment of physical employment standards.

NOTES:

CORRELATIONS BETWEEN LABORATORY MEASURES OF PHYSICAL FITNESS AND SOLDIER TASK PERFORMANCE.

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INTRODUCTION

All U.S. Army Soldiers are expected to competently perform a number of tasks, such as lifting heavy loads or walking with a backpack. Testing for performance of these tasks is done infrequently. The purpose of this study was to determine the physical fitness components underlying soldier task performance to be used for return to duty assessment and physical training.

METHODS

37 male Soldiers completed a battery of soldier tasks on four occasions, separated by at least one week. The battery, performed in order, consisted of: 1) a 30-m grenade throw (GT) for accuracy; 2) a running long jump (RLJ) while wearing a 20.5-kg fighting load; 3) a one-repetition maximum (1RM) box lift (BL) from the ground to 155 cm; and 4) a 3.2-km load carriage (LC) wearing a 33-kg load. Soldiers also performed laboratory and field tests of physical fitness, including peak oxygen uptake (VO2peak), 1RM bench press, 1RM leg press, bench throw using 30% 1RM, seated medicine ball put, standing long jump, and vertical jump. Height and body composition (via dual-energy x-ray absorptiometry) were also measured. The mean of trials 2-4 of the soldier task battery was used to correlate with the physical fitness tests via Pearson product-moment correlations ($\alpha = 0.05$).

RESULTS

Grenade throw, running long jump and box lift were significantly correlated with each other, but load carriage was not. Correlations between physical fitness and soldier tasks are listed in the table. Grenade throw was significantly correlated with long jump. Load carriage was significantly related to VO_{2peak}. Running long jump and box lift were correlated with lean body mass, and measures of upper and lower body power. Box lift was also correlated with height and strength.

CONCLUSIONS

Standard measures of physical fitness were better related to running long jump and box lift than to grenade throw and load carriage. It may be possible to use measures of physical fitness to assess soldiers' combat readiness. These relationships can also be used to develop training programs to prepare Soldiers to perform physically demanding tasks.

Table. Correlations between Soldier tasks (mean trials 2-4) and physical fitness measures (n=37).

	$VO_{2\,pk}$ ($ml \cdot kg^{-1} \cdot min^{-1}$)	Height (cm)	Lean Body Mass (kg)	Bench Press (kg)	Leg Press (kg)	Bench Throw Peak Power (W)	Med Ball Put (cm)	Long Jump (cm)	Vertical Jump (cm)
GT (cm)	-0.06	-0.27	-0.21	-0.15	0.01	-0.12	-0.23	-0.36*	-0.32
RLJ (cm)	0.18	0.28	0.39*	0.23	0.31	0.41*	0.50*	0.91*	0.78*
BL (kg)	-0.22	0.48*	0.77*	0.58*	0.59*	0.68*	0.75*	0.52*	0.50*
LC (min)	-0.42*	-0.24	0.04	0.11	0.22	0.15	0.07	-0.08	0.05

*Statistically significant, $p \leq 0.05$.

NOTES:

DEVELOPMENT OF "EXERCISE DOSIMETRY" TO ADDRESS MUSCULOSKELETAL INJURIES WITHIN THE MILITARY.

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INTRODUCTION

Musculoskeletal injuries (MSI) are responsible for the greatest loss of duty days, medical treatment costs and medical disability discharges within the US Army. While studies have been able to characterize the type and causes of MSI with training environments, this has been more difficult to do in the deployed setting. Our recent studies have shown that "overuse" is the primary cause for MSI in deployed troops. These overuse MSI are largely due to the cumulative effects of the physical loads/demands being placed upon Soldiers. It will be difficult to reduce MSI within the military until we have more precise measurements of the types and cumulative physical demands being placed upon Soldiers while training or deployed. The purpose of the current effort is to develop a suite of biomechanical sensors capable of quantifying the physical demands being made that can be worn by a Soldier over long periods of time (weeks/months).

METHODS

Small wearable devices, using new technologies to measure forces, acceleration, torques and position in space are being tested to determine if they can accurately characterize and quantitate the physical demands being incurred by a Soldier while he/she is performing their duties. The analogy is to "physiological monitors" being worn to record parameters such as heat rate, core temperature, respiration, etc.

RESULTS

Sensor systems, using inertial sensors, gyroscopes, tri-axial accelerometers and pressure sensors have been designed to measure biomechanical parameters at 100 Hzs over long periods of time (weeks/months). These devises are small, light in weight (<200 gms), require minimal power and have essentially no impact on the person's ability to function. The utilization of these "exercise dosimeters" will, for the first time, enable the total physical work and resultant forces in the musculoskeletal system to be determined and recorded. These data, in combination with medical information, will provide the information necessary to more carefully define the relationship of the amount and type of mechanical forces and their relationship to overuse injury.

CONCLUSIONS

New sensor technologies are being used to develop "exercise dosimetry" types of devices and systems that will provide the necessary information to truly understand and define the relationship between the physical demands of Soldier activities and how these contribute/cause the overuse musculoskeletal injuries being incurred.

IMPLEMENTING PHYSICAL EMPLOYMENT STANDARDS IN LARGE ORGANISATIONS.

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KEYNOTE PRESENTATION

In Canada, both legal and human rights legislation impose definitive requirements for the development and implementation of defensible physical employment standards (PES). As such significant efforts and resources are often required from the Canadian Forces to ensure that PES are physiologically linked to the essential demands of the occupation. Equally important but often under emphasized is the process of successfully implementing these new standards. This is especially true of large decentralized organizations such as the Canadian Forces where leadership changes, logistical challenges and competing group interests can delay or even cancel the adoption of a new PES. This presentation reviews Project FORCE and other Canadian Forces PES as examples to illustrate the steps, challenges and solutions involved in implementing new tests and standards in large or military organisations. While the implementation of each Canadian Forces PES can be considered unique, there are definite commonalities observed across the research, development and delivery phases which facilitate the implementation process. At the commencement of research projects to develop and implement a Canadian Forces PES, a Strategic Initiating Directive is produced and a Project Management Teams established. The Strategic Initiating Directive is an overarching document which confirms senior leadership support and identifies key stakeholder roles and responsibilities. The Project Management Team is comprised of senior research, client and partner representatives and provides ongoing project oversight. With Project Management Team support and the research process near completion concurrent implementation efforts can be undertaken. This can include the drafting of supporting career, screening and medical policy as well as the development of supporting fitness programs to reduce any potential adverse impact. Fitness programs are web based for maximum reach and comprised of general, functional and operational training modalities that are based on job related demands. Following the completion of the research process, the results, impact analysis and delivery timelines are presented to the approval authorities. Given that the implementation of a PES involves a delicate balance between scientific validity and logistical feasibility a number of test options are typically presented. Test options will range from adopting simple fitness predictors which are easy to administer with little or no equipment to more cumbersome task simulations that look and feel like the job. Once the test option is selected and approval provided the final implementation process begins. A manual outlining formal guidelines, protocols and testing procedures is produced while formal training of evaluators and reporting procedures are established. The PES may be implemented as a training objective for one year to familiarize Canadian Forces personnel with the new test protocols and standards while also providing

opportunities to adapt training. Following the trial, an assessment of the true adverse impact is completed, supporting policies are subsequently published and the new Canadian Forces PES is officially adopted with ongoing monitoring. While implementation efforts can be time and resource intensive, the execution of a carefully considered implementation process can facilitate stakeholder engagement, consolidate diverging views, ease employee anxiety, and ultimately result in the successful adoption of new or revised PES.

NOTES:

QUANTIFYING PERFORMANCE STANDARDS OF THE COMMON AND ESSENTIAL TASKS REQUIRED OF THE CANADIAN FORCES. PHASE II.

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INTRODUCTION

Potential scenarios and performance standards developed by military subject matter experts for the critical and essential tasks required of the Canadian Forces were used to simulate and quantify the physiological demands. The most demanding physical components were identified and form the basis of the minimum physical fitness evaluation for all CF personnel.

METHODS

Operational scenarios developed with the following tasks were recreated in the field at operational pace as defined by Subject Matter Experts (1) Lift and carry jerry cans (2) Sentry duty (3) Sandbagging (for flood relief and sentry building) (4) Escape to cover (5) Construct a fence (6) Casualty extraction from a vehicle (7) Casualty evacuation on a stretcher (8) Casualty evacuation down stairs (9) Digging ablution facilities (10) Clearing rubble to rescue a casualty. Scenarios took from 3 minutes up to 4 hours long to ensure realism. Following pilot research with civilian or military participants (N= 2-16) tasks were either (1) *concentrated* to the most demanding elements (2) *combined* to reduce redundancy (3) *eliminated* due to very low demands. Tasks with predominantly strength demands were measured using a calibrated load cell (MyoTrace 400, Noroxon, USA). Tasks of (1) Digging ablution facilities (2) Carrying jerry cans (3) Constructing a pickets and wire fence and (4) Sandbagging, were further investigated to determine the metabolic demands with the Jaeger Oxycon Mobile analyzer. Military participants performing each task (N=16) were stratified by mass, height and gender as these components influence the demands of the task (Hansson & Oberg, 1996).

RESULTS

The most demanding muscular strength components were identified as the casualty evacuation tasks (drag 82kgs, lift 48kgs, carry 40kgs). Escape to cover (68 sec simulation 25.5-37.6ml/kg/min) and Carrying jerry cans (18.8 ± 6.1ml/kg/min) were determined to primarily require anaerobic metabolism. Whereas the more aerobic demands were concentrated components of picking and digging (1.8L/min for 18mins), load carriage during fence construction (16.8-20.8 ± 5.1 ml/kg/min for 23 minutes) and the lifting of sandbags (1.35 ± 0.2L /min for 15 minutes).

CONCLUSIONS

The physiological demands (strength, anaerobic, aerobic) that could limit successful operational

performance were isolated, in order to be simulated in a gym environment for Phase III of FORCE; where the most feasible fitness tests that best predict successful performance will be determined.

REFERENCES

Hansson, P., and Oberg, K. (1996). Analysis of biomechanical load when shovelling. JASH, 2(3): 124-142

NOTES:

ESTABLISHING A BASELINE PHYSICAL EMPLOYMENT STANDARD FOR THE CANADIAN FORCES: PROJECT FORCE.

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INTRODUCTION

Given that Canadian Forces minimal physical fitness requirements are nearly 25 years old and may not reflect current operational realities, a revalidation of this standard was undertaken in 2010. Given Human Rights legislations governing the implementation of physical employment standards in Canada, Project FORCE (Fitness for Operational Requirements of CF Employment) followed an exhaustive 3 phase process – this to ensure that the resulting standard would be relevant to both non commissioned members and officers, working in all 102 occupations of the Royal Canadian Navy, Canadian Army and Royal Canadian Air force. Phases I and II of Project FORCE identified the nature and physiological demands of 6 tasks which were deemed to be essential and common to all Canadian Forces Personnel: These tasks are a Stretcher Carry, a Casualty Extrication, Sandbag Fortification, Escape to Cover, Picking and Digging and Picket and Wire Carry.

METHODS

Given the logistically cumbersome nature of the 6 tasks, Phase III was designed to assess whether simplified simulations and fitness predictor components could predict performance of the 6 common tasks. Following physiological and biomechanical analysis of the 6 tasks, a battery of 13 field tests (e.g., farmer's carry, wall sit, 20-m shuttle run) was designed as potential predictive fitness tests. These tests were administered to a stratified sample of 600 Canadian Forces personnel who also completed simulations of the 6 common tasks, all to their safe maximal ability (either as quickly as possible or with the maximal weight possible depending on the nature of the task/test). A secondary purpose of the stratification was to ascertain predicted pass rates of incumbents on the eventual new fitness test, and whether any particular segment of the population would be adversely impacted. Simple correlations and linear regressions are performed to determine which combination of field test components most accurately reflect the demands of the 6 common tasks all the while being feasible to administer to nearly 75 000 personnel annually.

RESULTS

Out of the 13 potential field test components, several options for a fitness test will be presented. Each option will be described along with its predictive validity and associated logistical considerations. Emphasis will be placed on the likelihood of Type I and Type II error with each

predictive test battery, as well as the proportion of variance explained by each model.

CONCLUSIONS

The development and implementation of a single physical employment standard in a large, multi-occupation organisation represents many scientific and logistical challenges. The Canadian Charter of Human Rights and corollary case law provide a framework which allows researchers to develop operationally relevant and scientifically sound physical employment standards.

NOTES:

ESTABLISHING OCCUPATIONAL FITNESS STANDARDS (OFS) IN THE CANADIAN FORCES: A REVIEW OF NON-COMMISSIONED AND OFFICER OCCUPATIONS IN THE ROYAL CANADIAN NAVY (RCN).

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INTRODUCTION

Occupational Fitness Standards (OFS) are a part of the medical standards for each Canadian Forces (CF) occupation. They consist of a list of essential and demanding tasks that a member must be able to perform in order to remain in that occupation. The review process for each CF occupation is a three step process: 1) compilation of occupation specific information, 2) identification of essential tasks that are physically and/or psychologically demanding, 3) quantification/categorization of the tasks demands. The review of all Royal Canadian Navy (RCN) occupations has been completed and the results will focus on our findings within this environment.

METHODS

The first step in identifying essential and demanding tasks for RCN occupations was to gather all relevant information from available sources (e.g. job descriptions) and compile an extensive task list. This list was then refined by Subject Matter Experts (SMEs) who eliminated the tasks that were not essential. A group of 5 SMEs participated in a one day focus group in which consensus was obtained on essential and demanding tasks using the TRIAGE technique (Gervais & Pépin, 2002). The SMEs then developed a scenario for each essential task to allow for quantification of physical demands, psychological requirements, and environmental factors. This information is included in an interactive tool which allows end-users to objectively assess a member's suitability for employment by comparison of their capacity against the four levels of CF fitness standards: universal (soldier first principle), environmental, occupational, and specialty.

RESULTS

Our review of the RCN occupations (n=12) produced an average of 8.75 (range; 5-13) tasks per occupation. Based on their physical demands, five occupations are considered not demanding (lift/carry <25 lbs), five are considered moderately demanding (lift/carry 25-100lbs), and two are considered highly demanding (lift/carry >100lbs).On the collective psychological dimensions of attention, memory, communication, problem solving and decision making, five occupations were found to be highly cognitively demanding (>90% of tasks), with two involving moderate cognitive demands (50-90%), and five occupations scoring low (<50%) in cognitive demand categories. In addition, seven occupations have more than eight environmental factors affecting the demands of their tasks.

CONCLUSIONS

Our process allows SMEs to identify tasks that are both physically and psychologically demanding. In addition to the tasks required of them in their own occupations, Sailors are also required to perform universal tasks that are part of shipboard duties. The demands of these tasks,

for example "damage control" are often over and above the demands of their occupations and become the limiting factor when determining a sailor's deployability. The next step in this process for the RCN will be to examine the essential tasks associated with shipboard duties in order to propose an updated environmental fitness standard.

REFERENCES

Gervais M, Pepin G. (2002). *Eval J Australasia*, 2(2), 45-49.

NOTES:

DEVELOPMENT OF GENDER-FREE ROLE-RELATED PHYSICAL TESTS FOR THE BRITISH MILITARY AND UNITED KINGDOM EMERGENCY SERVICES.

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INTRODUCTION

In the United Kingdom physical selection tests should comply with equality legislation (i.e. Equality Act 2010) and provide the basis for selecting and retaining personnel who are physically suited to their roles. The aim of this paper is to provide an overview of the range of physical selection tests developed for the British Army, Royal Air Force (RAF), UK Fire and Rescue Service (FRS), UK Department of Health (DoH), and Police Service for Northern Ireland (PSNI).

METHODS

Following ethics approval, tests were developed using a similar approach. Firstly, job analyses were conducted and/or scrutinised to document the physically demanding aspects of personnel's roles using a combination of questionnaires, observations, expert panel discussions and measurements of the physiological responses during the tasks. Secondly, tests to measure the physical aspects of these roles were developed and their reliability (test-retest) and content or criterion validity assessed. Thirdly, pass standards were set to reflect the physical demands of the roles being tested. Fourthly, the likely impact on the workforce was assessed. Finally, the test battery was assembled.

RESULTS

Role-related tests were developed for each organisation which reflected the physical requirements of the key tasks required of personnel in service (Table 1). Gender-free and role-related pass standards were set for each test.

Table 1 – Role-related tests developed for military and emergency service organisations.

Organisation	Application	Role-related Tests Series
British Army	Joining	Single box lift, water can carry, loaded march
RAF	Operational deployment	Single box lift, repetitive lift & carry, fire & manoeuvre, digging
UK FRS	Joining	Equipment carry, casualty evacuation, breathing apparatus crawl, ladder climb, ladder lift
UK DoH	Specialist role	Physical competency assessment circuit (including casualty drag and manual dexterity), enclosed space test, ladder climb
PSNI	Joining & specialist roles	Physical competency assessment circuits

CONCLUSIONS

These examples show the diversity of gender-free role-related tests developed for military and emergency service organisations to test participants' physical capability in line with employment law. This approach is likely to help optimise physical performance and decrease injury risk.

NOTES:

A SURVEY TO IDENTIFY PHYSICALLY DEMANDING TASKS PERFORMED DURING STORM DAMAGE OPERATIONS BY AUSTRALIAN STATE EMERGENCY SERVICES PERSONNEL.

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INTRODUCTION
The purpose of this research was to identify and characterize the physically demanding tasks performed by SES personnel during storm damage work.

METHODS
Thirty-six tasks identified as the most operationally important to storm damage work were included in a survey which was available to all SES volunteers. The survey aimed to identify the physical demand, operational importance, frequency, duration, principal actions and fitness components of each task.

RESULTS
Twelve tasks were identified as the most physically demanding. Of these, carrying sandbags, lifting sandbags and shovelling sand (with hands) rated highest. Covering roof damages with tarpaulin and erecting external weather proofing were ranked highest for operational importance. Box lifting (single-person) and erecting external weather proofing returned the highest mode values for frequency, whereas tasks involving handling sandbags returned the highest mean and median frequency values. Covering roof damages with tarpaulin was identified as the longest task. Bending, lifting, twisting and carrying were the most common actions identified for the physically demanding tasks. Muscular strength and muscular endurance were the primary fitness components identified for the twelve tasks.

CONCLUSIONS
SES personnel perform a variety of storm response tasks, many of which are physically demanding. All or most of the physically demanding tasks contain elements of bending, lifting, twisting and carrying, and call upon personnel's muscular strength and muscular endurance capabilities.

NOTES:

DYNAMIC LIFTING PERFORMANCE AMONGST MILITARY POPULATIONS.

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INTRODUCTION

Following the implementation of physical employment standards in the Australian Defence Force, personnel will undergo a whole-body strength assessment task. The proposal for this task is a box lift and place onto a platform, as this reflects several essential military tasks. The aim of this study was to gain an understanding of the performance of this task within currently serving personnel.

METHODS

Male Military personnel (n=210) from the Australian Defence Force, performed a maximal box lift test (lifting a 0.35 m^3 box from the ground to a 1.50 m platform). The percentage of personnel who passed two generic lifting standards (25 and 30 kg), which reflect non-combat and combat lifting demands respectively, was calculated. In addition to generic standards, passing rates were calculated for personnel operating in four combat trades, which each had a specific trade standard.

RESULTS

Across all personnel, 100.0% and 99.5% passed the 25 kg and 30 kg standards respectively. The percentage of personnel who passed their trade-specific standard ranged from 66.7% to 90.3 %.

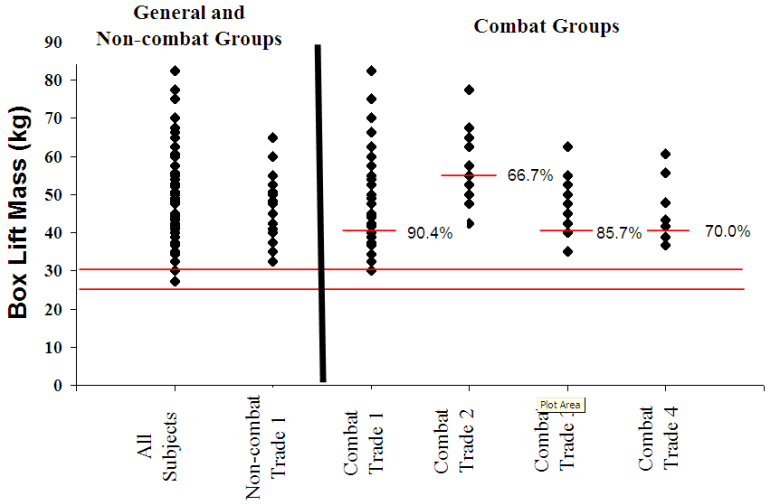

Figure 1: Box lifting performance amongst personnel in combat and non combat trades. Data highlight the percentage of personnel who passed two generic standards (horizontal lines) as well as four trade-specific standards (shorter horizontal lines). Percentages on the graph illustrate the

passing rate for that trade standard. Standards were calculated through comprehensive job analysis

CONCLUSIONS

Passing rates for two generic standards were very high with only one participant failing the combat standard. The more demanding trade-specific standards had a decreased pass rate, however in every case the majority of participants achieved the trade-standard.

NOTES:

THE WARRIOR FITNESS TRAINING PROGRAM: A FOLLOW-UP STUDY ON RECRUITS WHO WERE UNABLE TO ATTAIN THE BASELINE PHYSICAL EMPLOYMENT STANDARD UPON ENTRY TO THE CANADIAN FORCES.

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INTRODUCTION

Since October of 2006, recruits who do not attain minimal physical employment standards for entry into basic training are diverted to the Warrior Fitness Training Program rather than being refused entry into the Canadian Forces. The primary purpose of this study was to assess the indicators of fitness, lifestyle, affect, mastery and hardiness in Warrior Fitness Training Program graduates and compare these data to personnel who entered the CF directly via basic training. This was done in order to ascertain the long-term effectiveness of the Warrior Fitness Training Program as a tool to improve the fitness of these military recruits who would have previously been denied entry into the Canadian Forces.

METHODS

The health behaviours and select psychological indicators of Warrior Fitness Training Program graduates were assessed by means of a self-administered paper questionnaire (in the spring/summer of 2012). Results of this questionnaire were compared to two different sources of data: Firstly they were compared to the general Canadian Forces population in terms of pass rates on their annual fitness test. Subsequently their responses were compared to the responses they gave to identical questions on the Recruit Health Questionnaire upon to entry into the Canadian Forces (an indication of their health and lifestyle prior to enrolment). In this way Warrior Fitness Training Program graduates were measured in relation to their peers in the Canadian Forces as well as being compared to their own responses 2-5 years prior to track changes in health, fitness, lifestyle and psychological correlates. For the current presentation, only data relating to physical employment standards will be reported.

RESULTS

Preliminary analyses of self-reported data indicated that of the 141 respondents who had completed their annual fitness assessment in the previous 12 months, 95.7% successfully attained their established physical employment standard. Cross-tabulation analyses showed no statistical difference between this proportion and that of the general Canadian Forces population (χ^2:0.199; p:0.656).

CONCLUSIONS

Results suggest that the education and training provided in the Warrior Fitness Training program have aided graduates in maintaining their fitness in the early part of their military career. From an organisational perspective, decision-makers within the Canadian Forces will now have encouraging data on which to base decisions about the long-term viability and effectiveness of this program.

NOTES:

HOW MUCH MONEY COULD FIRE BRIGADES SAVE ANNUALLY SIMPLY BY INCREASING FIREFIGHTER FITNESS?

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INTRODUCTION

At this conference, several organisations have described injury rates in stressful occupations. In some cases, injuries are associated with non-work activities, often most prevalent in younger people. Indeed, across the manual-trade industries, workplace injuries occur most frequently within young, inexperienced workers. However, in some jobs, the reverse is observed, and this tendency, we suspect, is linked with habitual exercise behaviours. Herein, the case is presented that fire brigades, and perhaps other emergency services, can reduce both the rate and financial burden of workplace injuries, simply by increasing the health and fitness of employees.

METHODS

Firefighter injury data were extracted for 1998-2007 (Australia) from a database maintained by a Workers' Compensation insurer. Within an organisation employing 3,514 permanent and 3,390 on-call firefighters, injuries and near-misses sustained at work that led to lost work time or medical treatment entered this database. Data were normalised to 1,000 full-time employees. The savings identified below include only the compensation claims. However, the potential savings, as reflected within insurance premiums, can be several times greater.

RESULTS

Annual averages were: 170.5 injuries, 41.4 years of lost time and $2,829,682 in claims per 1,000 firefighters. Individuals aged 40-50 years accounted for 38.4% of all injuries, but there was a significant under-representation of firefighters <30 years, with 9.3% of the workforce suffering just 2.4% of all injuries. Injury rates were skewed towards the older ages: 40-50 y = 17.6%, 50-60 y = 23.9%, 60-70 y = 77.1%. Firefighters over 40 y had an injury probability 4-18 times higher than those <30 y. Thus, if the injury rate of 30-40-y-old males (11.7%) could be retained as firefighters aged, then 237 fewer injuries would occur each year in males >40 y, and the age- and gender-specific saving would be $5,687,934 per annum. The single most common injury types were joint and muscle strains and sprains (65.6% of all injuries). These incurred a net cost of $69,290,798 over this decade. There was also a very strong age dependency for these injuries, and this was linked very powerfully to the net cost of claims.

CONCLUSIONS

With the exception of emergencies, fire fighting is a somewhat sedentary occupation. Since, habitual inactivity leads to many degenerative states that predispose to injury, then implementing

structured health, fitness and rehabilitation programmes that target older firefighters will reduce their high injury rates, and yield significant personal and organisational savings.

This research was funded by Fire & Rescue New South Wales (Australia).

NOTES:

METHODOLOGICAL APPROACH TO THE DEVELOPMENT OF PHYSICAL EMPLOYMENT STANDARDS FOR THE AUSTRALIAN DEFENCE FORCE.

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INTRODUCTION

Physical assessments and standards are used by organisations to assess the capability of personnel for demanding occupations. In military organisations it is accepted that an individual's capability may directly influence their effectiveness (Sharkey & Davis, 2008). In 2006 the Defence Science and Technology Organisation (DSTO) were tasked to develop Physical Employment Standards (PES) for all employment categories within the Australian Defence Force. The initial focus of this work was on Army; DSTO are also reviewing employment categories within Air Force and Navy.

METHODS

The approach followed by DSTO involves four steps lasting approximately 12 months, Table 1. The process requires engagement with employment category sponsors and managers to gain an appreciation of the trade. The scientific team then conduct field observations to quantify the demands of physically demanding tasks and these findings are reported back to employment category sponsors and managers to confirm the validity of the observations before proceeding to developing PES for the employment category.

Table 1: Summary of the employment category review process.

ACTIVITY	OUTPUT	KEY STAKEHOLDERS
Coordinating Conference	Agreed processes and arrangements for trade review	Employment Category Sponsors/Managers
Trade Task Workshop	Identified trade task list	Qualified Operators and Supervisors
Trade Task Field Observation	Quantified physical demand of trade tasks	Qualified Operators and Supervisors
Trade Task Confirmation Workshop	Finalised trade task list and criterion trade tasks	Employment Category Sponsors/Managers

RESULTS

For Army, DSTO have developed two baseline PES standards made up of four tests; assessing aerobic and anaerobic power and muscular strength and endurance. These are applied to all employment categories, but where trade requirements exceed the baseline, the test standard is raised to match the demands of the employment category. Consequently, every employment

category will have its own PES standard applied. In the rare event where criterion tasks do not correlate strongly with the baseline suite of tests, specialised assessments have been recommended.

REFERENCES

Sharkey, B. J. and Davis, P. O. (2008). Hard work: defining physical work performance requirements. Champaign, IL, Human Kinetics.

NOTES:

VALID CARDIOVASCULAR ENDURANCE ASSESSMENTS FOR DIRECT COMBAT ROLES IN THE AUSTRALIAN ARMY MUST INCORPORATE LOAD CARRIAGE.

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INTRODUCTION

Up until recently women have been excluded from service in Australian Army employment categories involving direct combat duties, including Engineers, Armoured, Artillery and Infantry. Such roles require personnel to conduct dismounted duties and tasks in high threat environments necessitating the need for load carriage. Current Australian Army fitness assessments are performed in an unloaded state and are not strong predictors of performance in tasks involving load carriage (Bilzon *et al*., 2002).

METHODS

A structured job analysis was conducted for all Australian Army employment categories involving direct combat duties. Cardiovascular endurance tasks were quantified in a field setting, via measurement of physiological data (e.g., VO_2) together with key performance parameters. Subsequent analysis of data allowed for the identification of the most physically demanding and critical (criterion) tasks for each employment category, and for generic military requirements applicable to all roles involving direct combat duties. Physical employment assessments and standards were then developed based on these criterion tasks.

RESULTS

All criterion tasks required dynamic whole-body movement and were typically performed for a sustained period (4 min to 480 min), with walking being the most common mode of locomotion. All tasks required soldiers to carry an external load ranging from 23 up to 70 kg. Task involved elements of both imposed and self paced work rates with oxygen consumption ranging from 1.69 $L \cdot min^{-1}$ to 2.75 $L \cdot min^{-1}$. Assessments and standards were developed to represent the demands of employment category specific, as well as generic tasks. It was determined that personnel serving in direct combat roles must be able to complete as a minimum, a 10 km forced march with 38.4 kg external load within 1 hr and 50 min (VO_2 2.00 ± 0.24 $L \cdot min^{-1}$). More arduous employment categories had higher standards.

CONCLUSIONS

Employment within direct combat roles in the Australian Army necessitates the capacity for sustained load carriage. Testing and assessing personnel against this requirement is critical to

ensuring an able and effective combat force.

REFERENCES

Bilzon, J., Scarpello, E., Bilzon, E., and Allsopp, A. (2002). *Occup Med,* 52(8): 503-510.

NOTES:

IDENTIFICATION, REVIEW, AND ANALYSIS OF MUSCULAR STRENGTH AND MUSCULAR ENDURANCE TASKS IN THE AUSTRALIAN DEFENCE FORCE.

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INTRODUCTION

Aligning physical job requirements with physical capacities through the implementation of physical employment standards (PES) has previously been shown to improve operational effectiveness and reduce injuries (Bunch *et al,* 2004). In the manual handling domain, job-related tasks are grouped into two categories: muscular strength, in which a specific muscle or muscle groups are required to generate an absolute force for successful task completion, and muscular endurance, which require execution of repeated muscular contractions or a sustained and constant contraction for a prolonged period of time. This paper will report on the identification, review, and analysis of manual handling tasks in the Australian Defence Force (ADF).

METHODS

One hundred and twenty-two manual handling tasks were identified from the observation of 37 ADF employment categories. Firstly, through the direct field observation of these 122 tasks, physically demanding criterion tasks were defined. Secondly, parameters such as frequency of lift, height of lift, and lifting posture were used to categorise the criterion tasks into representative movement-based clusters. Thirdly, maximal performance testing was used to establish relationships between task simulations and the muscular strength (box lift and place – BLP) and muscular endurance (jerry can carry – JCC) PES assessments. Finally, these relationships were used to assign the appropriate PES assessment and standards based on the task demands.

RESULTS

Sixty-two percent of the tasks observed were muscular strength and 38% were muscular endurance. Lifting was most commonly observed (78%) with a mean individually lifted object mass of 31 ± 13 kg. Tasks were divided into eight movement-based clusters of which 'lift to a platform' (48%) was the most common. From this, 58 criterion tasks were identified and equations developed to relate the movement-based clusters to physical assessments.

CONCLUSIONS

This paper has described the identification and quantification of manual handling task demands across 37 ADF employment categories. The implementation of PES will ensure alignment between task demands and physical capacity, thereby enhancing operational effectiveness and

reducing injuries.

REFERENCES

Bunch, R., N. Doucette, S. Kalkan, and I. Sealy. (2004) *Int Conf on Health Safety and Env in Oil and Gas Exp and Prod*, 983-988.

NOTES:

THE EFFECT OF LOAD CARRIAGE ON THE PERFORMANCE OF TACTICAL MOVEMENTS IN THE AUSTRALIAN ARMY.

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INTRODUCTION

Dismounted combatants engaged with an enemy force must move tactically between points of cover (involving repeated short-duration, high-intensity movements) while wearing protective and military specific equipment. The aim of this study was to quantify the effect of load carriage on performance (movement duration and peak velocity) of two simulated tactical movement tasks.

METHODS

Participants included nineteen Airfield Defence Guards (age 21.7±2.4 years, height 181.4±8.0 cm, body mass 81.0±9.0 kg). A fire and movement (FM) simulation involved sixteen 6-m bounds commencing every 20 s, each starting from a prone position and ending in a kneeling position. The break contact (BC) simulation involved five 30-m sprints starting from a prone position every 44 s. Five Load conditions (A – E) were evaluated for each simulation, ranging from 10–30 kg at approximately 5-kg intervals and included chest webbing, protective vest, helmet, and a replica weapon. Participants wore a global positioning device (10 Hz) which also contained nine inertial sensors. The data were analysed by custom software algorithms to objectively identify the start and end points of each bound or sprint. Repeated measures ANOVA assessed statistical differences between conditions.

RESULTS

Overall, mean bound duration increased by 0.8% and 0.9% per kilogram increase in external load for the BC and FM respectively (referenced to condition A, Table 1). Peak velocity significantly decreased with increasing external load in the BC, but not in the FM (Table 1). Time to reach peak velocity, expressed as a percentage of bound duration, was not different among conditions but differed between the simulations (BC ~ 75% of bound duration; FM ~ 60% of bound duration).

CONCLUSIONS

Increasing the amount of external load carried by the dismounted combatant significantly impairs the ability to perform tactical movement tasks.

TABLE 1: Assessment performance for each load condition; values are mean (standard deviation).

	n	Load Condition					p
		A (10 kg)	B (15 kg)	C (20 kg)	D (25 kg)	E (30 kg)	
Mean bound duration (s)							
BC	19	6.71(0.42)	7.00(0.38)	7.25(0.38)	7.47(0.43)	7.84(0.56)	**<0.001**
FM	19	3.72(0.26)	3.86(0.29)	4.09(0.31)	4.32(0.43)	4.53(0.41)	**<0.001**
Peak velocity ($m \cdot s^{-1}$)							
BC	14	6.42(0.29)	6.17(0.38)	5.93(0.30)	5.90(0.36)	5.65(0.32)	**<0.001**
FM	14	2.65(0.26)	2.67(0.26)	2.58(0.30)	2.51(0.30)	2.42(0.25)	0.095

NOTES:

IMPLEMENTING PHYSICAL EMPLOYMENT STANDARDS – THE AUSTRALIAN ARMY EXPERIENCE.

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INTRODUCTION

In January 2013, the Australian Army will implement Physical Employment Standards (PES) following six years of scientific research and planning. The Defence Science Technology Organisation (DSTO) has developed PES for all Employment Categories (EC). Finalising standards and determining the best application of PES across Army has been a long process with many lessons learnt. These experiences, from a uniformed member's perspective, are to be shared to benefit other military organisations seeking to produce and implement PES.

METHODS

In order to facilitate the scientific research and prepare for implementation, the following organisational and procedural actions were taken: an Army Staff Officer was embedded into the research team to assist with planning and to facilitate the conduct of research activities with Army units; a governance structure was established to provide management and overall direction to the project; and frameworks and reporting mechanisms for the provision of subject matter expertise and endorsement of work were integrated into all stages of the research process. On receipt of recommended standards and PES assessments (PESA) there was a final period of review and amendment. Once finalised, Army-wide trials were conducted to validate standards and determine implementation requirements, such as resources and amendment of physical conditioning policy.

RESULTS

PES will be introduced at the same time as all EC (including combat roles) are opened to women and PES will provide an objective and credible means of selection and ongoing employment. The Australian Army will implement PES testing during initial training, as an annual assessment and prior to operational deployments. Key enablers, including: testing protocols and training programs have been developed and promulgated. Army units have been resourced with PESA equipment and body armour in order to achieve testing. Validation trials were successful and provided outcomes that were essential in final preparation for Army-wide execution. Finally, enduring support has been established for DSTO to continue to provide new (or update existing) PES as new capabilities or platforms are introduced into service.

CONCLUSIONS

The Australian Army and DSTO have been successful in developing PES for all EC within Army.

Through the life of the project, methods and processes have been continually refined to balance the scientific integrity and defensibility requirements with practical considerations that are critical to maximising successful service-wide introduction of PES.

NOTES:

SUBJECTIVE JOB TASK ANALYSES FOR PHYSICALLY DEMANDING OCCUPATIONS: WHAT IS BEST PRACTICE?

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INTRODUCTION

There are no published guidelines for physically demanding occupation (PDO) researchers conducting job task analysis (JTA). This presentation will critique existing JTA research, and provide guidelines for PDO researchers conducting JTA.

METHODS

The research selected for inclusion was sourced from PubMed and Google Scholar, using the key search terms: job task analysis, subject matter experts, job task ratings, importance ratings, frequency ratings, difficulty ratings, time-spent ratings, physically demanding occupations, task analysis reliability, personnel selection and factor analysis. Research examining methodological variations on JTA results was selected. The presentation will outline the expected validity and reliability of the most common task 'domains' in JTA research (importance, frequency, difficulty and time spent), and will propose appropriate statistical analyses for JTA data.

RESULTS

Ratings of task importance are not influenced by experience, job tenure, seniority, education, age or gender and can be accurately assessed by both small committees and large surveys of incumbents. Committees should be used with caution, as workplace perceptions of this approach may not be favourable. Frequency and time-spent ratings are influenced by experience; thus, large or stratified samples should be used to capture genuine inter-worker differences. Task difficulty may be better described as physical demand in PDO research and measured objectively using work physiology and ergonomics procedures. When reporting results, there are benefits in reporting more than one central tendency (e.g., mean, median and mode) and dispersion (e.g., SD, 95% confidence intervals) to reduce the impact of outliers on pooled results. The utility of exploratory factor analyses in JTA for PDO is limited.

CONCLUSIONS

Given the widespread use of workplace physical selection procedures, and the increasing rigour of the legal system, JTA must be carried out using scientifically robust methods. The presentation will advise on improving the accuracy of JTA data to truly reflect workplace practices. The information presented will serve as a reference point for any researcher conducting JTA for PDO, including the research priorities for advancing PDO-JTA methodologies.

RATIONALE FOR THE USE OF PHYSICAL SELECTION TESTS IN PHYSICALLY DEMANDING OCCUPATIONS: A REVIEW OF THE EVIDENCE.

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INTRODUCTION

Despite an increase in the implementation of occupational safety standards for physically demanding occupations, the physical working conditions cannot be easily regulated. As such, minimising the physical demands associated with the work is not always possible. The rebranding of volunteers as "workers" in the new Workplace Health & Safety Act (2011) has required a larger proportion of organisations to evaluate the duty of care to ensure all of their workers can work safely and competently. One method presumed to protect personnel in physically demanding work roles is to have workplaces preferentially select employees, by determining whether the physical abilities of a worker correspond to those needed 'on the job'. These decisions are often made using Physical Selection Tests. Physical Selection Tests are characterized as a test or series of tests which assess an individual's physical ability to perform job-related tasks. The prevailing rationale for introducing Physical Selection Tests includes a reduction in injury, illness and absenteeism rates and an increase in productivity in workers who successful meet the test standards. The scientific evidence-base to support these presumptions is very limited. This presentation will outline and critique the available evidence that PST produces a tangible effect on work injury, illness, absenteeism and productivity. The priority research areas to address the current limitations in the literature will also be presented.

REFERENCES

Workplace Health and Safety Act (2011). *An Act relating to work health and safety, and for related purposes*. Department of Education, Employment and Workplace Relations.

NOTES:

DEVELOPING, IMPLEMENTING AND REFINING PHYSICAL SELECTION STANDARDS FOR THE BRITISH ARMY.

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The British Army uses gender-free role-related tests to select the most physically suitable applicants to enter basic training and start their Army careers while complying with United Kingdom equality legislation (Equality Act 2010). This process, 'Physical Selection Standards for Recruits [PSS(R)]', was developed in the mid-1990's by Rayson and colleagues and implemented in 1998. This was the first time the British Military had used physical selection tests linked to bona fide occupational requirements. Following changes to basic training the validity of PSS(R) was re-assessed in 2001-02 and then further refined in 2010-12. This paper documents the process of PSS(R) development and implementation and the requirements for re-validation over the past 20 years.

Prior to the implementation of PSS(R), the British Army used measures of aerobic fitness and muscular endurance with gender-fair normative standards. This resulted in two shortcomings: (1) selecting applicants who were not physically matched to their occupational roles, (2) risk of legal challenge from disaffected applicants.

Between 1993 and 1997 a job analysis was conducted to define the frequency and physical demands of tasks undertaken by serving personnel, which led to the development of four Representative Military Tasks [RMTs: Single Lift (SL), Repetitive Lift and Carry (RLC), Carry, and Loaded March (LM)]. British Army applicants' could not undertake the RMTs due to health and safety constraints. Therefore, when PSS(R) was implemented in 1998, applicants' performed a 2.4 km run and a series of muscular strength and endurance tests to predict whether they would meet the RMT pass standards at the end of 12 weeks of basic training. At this time the RLC RMT was dropped due to logistical constraints. In addition, a risk management strategy and 'risk run modifier' were adopted to help meet manning targets and indentify individuals with a high risk of injury.

Between 1998 and 2002 the content, duration and number of basic training courses changed, which affected the development of fitness and material handling capability during training. Therefore, the models used to predict RMT performance were revised. The Carry test was also introduced at selection to better predict Carry RMT performance at the end of basic training, compared to the muscular strength and endurance-based predictive tests.

By 2010 there had been further changes to basic training and a desire by the Army to simplify the

PSS(R) selection tests. This resulted in the battery of muscular strength and endurance tests at selection being replaced by a SL, Carry, 2.4 km run and measure of body mass to predict performance on the SL, Carry and LM RMTs at the end of four different basic training courses, spanning 14 to 42 weeks in duration. In addition, all PSS(R) tests are now being trialled to be routinely conducted to a maximum effort to allow for a continuous rolling re-validation of PSS(R).

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NOTES:

DEVELOPMENT OF GENDER-FREE ROLE-RELATED PHYSICAL TESTS FOR THE BRITISH MILITARY AND UNITED KINGDOM EMERGENCY SERVICES.

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INTRODUCTION

In the United Kingdom physical selection tests should comply with equality legislation (i.e. Equality Act 2010) and provide the basis for selecting and retaining personnel who are physically suited to their roles. The aim of this paper is to provide an overview of the range of physical selection tests developed for the British Army, Royal Air Force (RAF), UK Fire and Rescue Service (FRS), UK Department of Health (DoH), and Police Service for Northern Ireland (PSNI).

METHODS

Following ethics approval, tests were developed using a similar approach. Firstly, job analyses were conducted and/or scrutinised to document the physically demanding aspects of personnel's roles using a combination of questionnaires, observations, expert panel discussions and measurements of the physiological responses during the tasks. Secondly, tests to measure the physical aspects of these roles were developed and their reliability (test-retest) and content or criterion validity assessed. Thirdly, pass standards were set to reflect the physical demands of the roles being tested. Fourthly, the likely impact on the workforce was assessed. Finally, the test battery was assembled.

RESULTS

Role-related tests were developed for each organisation which reflected the physical requirements of the key tasks required of personnel in service (Table 1). Gender-free and role-related pass standards were set for each test.

Table 1 – Role-related tests developed for military and emergency service organisations.

Organisation	Application	Role-related Tests Series
British Army	Joining	Single box lift, water can carry, loaded march
RAF	Operational deployment	Single box lift, repetitive lift & carry, fire & manoeuvre, digging
UK FRS	Joining	Equipment carry, casualty evacuation, breathing apparatus crawl, ladder climb, ladder lift
UK DoH	Specialist role	Physical competency assessment circuit (including casualty drag and manual dexterity), enclosed space test, ladder climb
PSNI	Joining & specialist roles	Physical competency assessment circuits

CONCLUSIONS

These examples show the diversity of gender-free role-related tests developed for military and emergency service organisations to test participants' physical capability in line with employment law. This approach is likely to help optimise physical performance and decrease injury risk.

NOTES:

METHODOLOGICAL APPROACH TO THE DEVELOPMENT OF PHYSICAL EMPLOYMENT ENTRY STANDARDS FOR THE AUSTRALIAN ARMY.

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INTRODUCTION

The Australian Army currently screens applicants using three generic physical tests (push-ups, sit-ups and a shuttle run test). These tests are broadly related to a particular physical capability but have no specific military job-related characteristics. Applicants who meet the required standards are enlisted to a given employment category before recruit training starts but are not streamed into specific jobs based on physical ability. In 2013 the Physical Employment Standards and Assessments (PESA), which are based on job-related military tasks, will be implemented within all Australian Army employment categories. It is, therefore, imperative that entry standards are developed based on the requirements of incumbents. This will allow recruits to be streamed at recruiting, which will ensure that only those individuals likely to be capable of performing critical job-tasks, once training has been completed, are accepted into a given employment category.

METHODS

Two hundred recruits will perform current generic (push-ups, sit-ups and shuttle run test) and military related physical assessments to maximal effort (box lift and place, jerry can carry and a 3.2 km modified loaded assessment) at the start, week-8 and end of a 12-week Recruit Training Course. At these time periods, twenty recruits will also complete physiological assessments including a one repetition maximum bench and leg press, a vertical jump test, a 30 s Wingate test and a VO_2max treadmill test. PESA, which includes a loaded march, a fire and movement simulation, a box lift and place and jerry can carry while wearing load (22 kg) will also be assessed at week-8 of the Recruit Training Course. A cohort of recruits will also be re-assessed at the end of a selection of initial employment training courses including Infantry, Armoured, Engineers, Artillery and Transport Corps.

RESULTS

This methodological approach will facilitate the Australian Army to 1) Review the initial training state of the applicant population 2) Review the training potential of key applicant populations and 3) Investigate the relationships between the performance of current generic and military related physical assessments at the start and end of the Recruit Training Course and Initial Employment Training.

CONCLUSIONS

This work will lead to the development of valid and defensible entry standards, which will support the inclusion of individuals most likely to be able to successfully perform the military tasks within a given employment category after a period of physical training.

NOTES:

DEVELOPMENT OF SCIENTIFIC SELECTION CRITERIA FOR PHYSICALLY DEMANDING POST PROFILES.

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INTRODUCTION

The process of developing scientific selection test battery for jobs that require high physical demands and specific human characteristics has received increasing attention globally over the past decade. A scientific test battery was developed for the South African Army for selecting new recruits based on the physical characteristics of the crew, and limitations of both the vehicle envelop and high physical task demands.

METHODS

Twenty-nine Armour crew members participated in the study. The participants' body dimensions (stature, shoulder or hip width, sitting eye height, and functional leg length) were taken to determine limitations of reach from the crew positions as well as functional viewing for the crew positions that use sights or episcopes. The leg push forces were taken at 70% of the force required to activate the foot pedals. Objects with mass of 15 kg, 35 kg and 45 kg were lifted from the floor to a 700 m high surface and the forces required to open hatches and operate the pedals were evaluated to represent the limits of functional strength capacity for performing the required tasks. The functional visual capacity was determined by using the functional acuity contrast test with an Orthorater and colour vision test was determined using the Ishihara colour vision charts.

RESULTS

Seventeen percent failed one or more of the anthropometric limitations, 21% failed one or more of the strength tests, 10% of the group failed on both anthropometry and the strength tests. No participant failed the colour vision tests and only one participant failed two of the six categories of contrast sensitivity as well as an anthropometric limitation. The vision test results alone did not result in failure for any participant. Likewise, no participant exceeded the limits for shoulder or hips width.

CONCLUSION

The test battery included aspects of anthropometric (body dimensions), functional strength, and visual capacities. Out of twenty nine participants that completed the test battery, 48% passed the full battery. The males who failed the test battery were taller than the stature limitation for the loader position and the females failed primarily due to having insufficient strength capabilities.

DEVELOPMENT OF A SIMULATED BODY DRAG FOR THE NEW ZEALAND ARMY.

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INTRODUCTION

A human body drag has been identified as one of the most physically demanding and critical physical tasks that the All Arms Soldier must be able to perform. Personnel are trained to complete this activity as a pair, but to assess competence, it is important that all soldiers are assessed individually. A simulated soldier mannequin was created using items commonly available to units and a subsequent evaluation of the mannequin drag versus the real life task performed.

METHODS

Twenty six, physically active University students (14 males: mean age 22.5 yrs, height 1.80 m, weight 78.7 kg; 12 females: mean age 28.2 yrs, height 1.70 m, weight 65.4 kg) performed a full body warm-up and were familiarised with the two tasks: in the human body drag, subjects paired up with a person of the same gender and approximate build and dragged a human casualty, with body armour and webbing, as quickly as possible, over a 15 metre course. The mannequin drag was performed individually, over the same course. The total weight of the mannequin was 50 kg, representing half of the mean weight of a deployed soldier plus their webbing (80 kg plus 20 kg of PPE). Trials were performed in random order with at least 3 minutes rest between trials. Time taken to complete each trial was recorded and heart rate was measured throughout. On completion of all trials, subjects were asked to complete a questionnaire to rate their perceptions of each activity.

RESULTS

In 156 trials there was only one failure. Standard deviations were high for both activities highlighting the large variance in results. Peak heart rate (HR_{peak}) was higher during the mannequin trials than during the human drag for 91% of subjects. However, this is largely explained by poor randomisation of trial order on Day 1. When data for Day 2, where trial order was evenly balanced, is considered alone, the difference in HR_{peak} associated with the two activities is small (5 $b \cdot min^{-1}$). Mean ratings for "hardness of the task" were similar for the human (4.5) and mannequin drag (4.7) and identical for "effort to get moving" (4.9). Little discomfort was reported after either activity and most subjects considered the two activities to be “quite similar”. A number of subjects found the handle on the mannequin difficult to hold.

CONCLUSIONS

Performance of the mannequin drag as part of a battery of All Arms task-specific tests would

provide a good assessment of an individual's ability to perform a human body drag, to an initial safe location, as part of a team of two. Ratings of difficulty were similar and heart rate differences between the two tasks were small, particularly when trial order was taken in to account. Recommendations to the test development team include the use of a RBAV shoulder strap as the handle on the mannequin; the use of consistent terms of encouragement; and the development of technical and physical conditioning guidelines to improve performance and reduce injury risk.

NOTES:

INDIVIDUAL CASUALTY DRAG PERFORMANCE.

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INTRODUCTION

Combat soldiers require the ability to individually drag an injured soldier a short distance to cover, and out of the line of fire so that emergency medical treatment can be provided (Reilly, 2010). There is scant evidence on performance time to complete a casualty drag; however the length of time the soldier and casualty are exposed to fire is a critical factor. The aim of this study was to investigate drag performance time as it relates to a range of casualty combat ensemble masses.

METHODS

Eighteen male Australian Defence Force soldiers (height 1.77 ± 0.07 m, body mass 83.4 ± 11.3 kg, 25 ± 7 yr) volunteered to participate in the study. Personnel conducted individual drags, moving backwards as fast as possible, over a distance of 10 m. Loads being dragged represented casualties wearing various combat ensembles (no load 80 kg, fighting order 105 kg, and marching order 120 kg). Linear regression was used to correlate casualty mass with the natural logarithm of 10 m individual drag times.

RESULTS

Mean drag time of an 80 kg casualty was 5.8 ± 0.8 s, 105 kg was 7.1 ± 1.2 s, 120 kg was 8.7 ± 1.8 s.

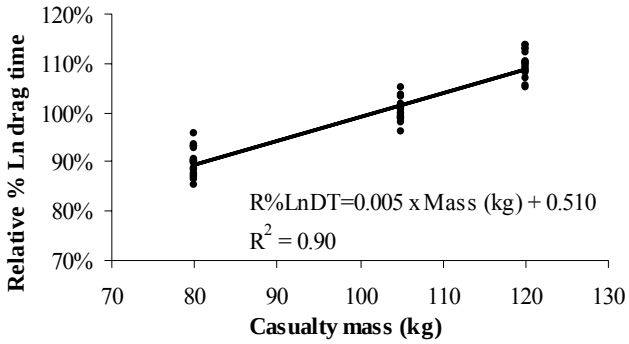

Figure 1: Relationship between mass and relative natural logarithm of 10 m drag time (R%LnDT).

CONCLUSIONS

A strong relationship was observed between casualty drag performance and the different combat

ensemble masses. Performing a casualty drag under fire is a critical task and these data can be used to establish standards that cover a range of combat ensemble masses. When compared to no external load (80 kg), fighting order (105 kg) and marching order (120 kg) increased drag time by 22.4% and 50.0% respectively. A casualty drag test could be administered to assess a soldier's capacity to rescue an injured soldier.

REFERENCES

Reilly, T. (2010), *The Canadian Army Journal* 13.2:59-69

NOTES:

MEDICAL CONCERNS RELATING TO DISCRIMINATION.

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ROUND-TABLE PRESENTATION

Employment health standards exist in a medicolegal context and must be able to withstand legal challenge. A brief medicolegal overview of development of the health standard for Fire & Rescue NSW firefighters, will be presented with a focus on disability discrimination and how it relates to other legislative considerations.

Discussion of what constitutes lawful versus unlawful discrimination will be presented, as well as additional considerations for safety critical workers such as firefighters.

Development of the Health Standard for Fire & Rescue NSW firefighters in relation to disability discrimination will be discussed, using the example of cardiovascular conditions.

REFERENCES

Health Assessment Standard for Firefighters. Draft, March 2012. Fire & Rescue NSW.

NOTES:

MILITARY EMPLOYMENT STANDARDS MUST CONSIDER GENERIC SERVICE REQUIREMENTS AS WELL AS EMPLOYMENT CATEGORY TASKS AND DUTIES.

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ROUND-TABLE PRESENTATION

The Australian Army has nine core behaviours it expects of all soldiers to ensure they are ready to meet all challenges on operation. Two of these behaviours are that every service member must be 'physically tough' and 'an expert in close combat'. In addition to these generic requirements, military personnel must also be physically capable of executing the tasks and duties relevant to their given employment specialisation.

Generic requirements that are essential to mission success and personnel effectiveness and common to all service members regardless of occupational speciality were integrated with the physical standards of all Australian Army employment categories. Using this approach, the higher standard (generic or employment specific requirement) for the key physical capacities of military service were applied as the employment standard.

Two distinct generic service requirements were developed, the All Corps Soldier (ACS) baseline and the Combat Arms (CA) baseline. The ACS baseline reflects the minimum level of generic military proficiency required of all Army personnel and is based on the performance of essential military duties which are typically defensive in nature. The CA baseline is applicable to all Arms Corps soldiers that are commonly required to operate in a high threat environment and conduct direct tactical action against the enemy. The ACS baseline was found to exceed the demands of many Combat Service Support and Combat Support employment category requirements and thus served as the military employment standard in these cases. Similarly, the CA baseline was found to exceed many of the Arms Corps employment category requirements for aerobic power, anaerobic power and muscular endurance physical capacities. The muscular strength requirements of many Arms Corps employment categories were found to be significantly higher than the CA baseline.

Generic service standards were found to exceed the requirements of a number of employment specialisations. This finding underlies to importance of integrating service and employment category requirements when formulating military employment standards.

INJURY MINIMISATION.

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ROUND-TABLE PRESENTATION

Injury is an almost inevitable outcome of military training, but all efforts should be made to reduce the incidence and severity of injury. Not all injuries are created equal – a muscle strain or sprained ankle cause temporary restriction, but often do not warrant withdrawal from training. More severe injuries such as stress fractures or back pain can result in prolonged rehabilitation and ultimate medical discharge.

Minimising injury requires constant surveillance of injury patterns and morbidity. The most common cause of injury is instructor or Commander 'enthusiasm'. Nietzsche may have meant his famous phrase in a different context, but Military instructors often have their own interpretation of the phrase "That which does not kill me, makes me stronger". The Australian experience shows that emotion will usually trump science in the training environment, and any interventions must target instructors as an essential component of any injury minimisation program.

NOTES: