Understanding Physical Fitness and Employment Standards

Orr, Rob Marc; Dulla, Joseph; Lockie, Robert G.; Dawes, Jay

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Understanding Physical Fitness and Employment Standards

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\textsuperscript{2}Tactical Research Unit, Bond University, Australia:

\textsuperscript{3}Los Angeles Sheriff’s Department, Los Angeles USA:

\textsuperscript{4}California State University, Fullerton, USA:

\textsuperscript{5}Oklahoma State University, Stillwater, USA.
Introducing Physical Fitness and Employment Standards

Robin Orr\textsuperscript{1, 2}

\textsuperscript{1}Bond Institute of Health and Sport, Bond University, Robina, QLD:

\textsuperscript{2}Tactical Research Unit, Bond University, Australia:
DR. ROB ORR

• PhD (Combat load carriage), MPHTY, BFET, ADFPTI, TSAC-F

• Australian Army
  • Infantry solider (ECN 343-2, 361), Physical Training Instructor (ECN 185)
  • Uniformed clinical physiotherapist, Human Performance Officer

• Bond University
  • Lead the Tactical Research Unit
  • Teach into Doctor of Physiotherapy Program / Supervise Higher Degree Research
  • 90+ tactical peer reviewed publications, 17 Technical Reports, 170+ presentations at national and international conferences
What is the purpose?

- Purpose of the testing
  - Injury prediction
  - Occupational capability
  - General health
  - Research
What is the purpose?

- Purpose of the testing
  - Why is this important?
  - To make the assessment fair
  - To make the assessment defendable
What is the purpose?

- General Police and Other Tactical Forces

- Examples of Push Up standards to enlist

<table>
<thead>
<tr>
<th></th>
<th>AFP</th>
<th>NSW Pol</th>
<th>VIC Pol</th>
<th>Q POL</th>
<th>NT POL~</th>
<th>TAS Pol</th>
<th>NZ Pol</th>
<th>UK Pol</th>
<th>Metro Pol</th>
<th>LA/ Reno</th>
<th>ADF</th>
<th>Fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>30</td>
<td>25*</td>
<td>5</td>
<td>N/A</td>
<td>5-25#</td>
<td>20</td>
<td>34</td>
<td>N/A</td>
<td>24</td>
<td>15**</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>10+</td>
<td>25*</td>
<td>5</td>
<td>N/A</td>
<td></td>
<td>3</td>
<td>20</td>
<td>N/A</td>
<td>24</td>
<td>8</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

* On toes or knees

~ 2 sec cadence

# Based on scoring system (5 repetitions = 2 points: 25 repetitions = 10 points)

+ Specialist is 30 reps

** 66 Repetitions to a 1:2 cadence for Special Forces
What is the purpose?

- Purpose of the testing – Setting standards
  - Male scores – 22 Repetitions
  - Female scores – 15 Repetitions

What if the PASS score was 20 Repetitions?
- Would that account for differences in sex strength levels?
What is the purpose?

- Purpose of the testing – Setting standards
  - Male scores – 22 Repetitions
  - Female scores – 15 Repetitions

What if the PASS score was 15 for Females and 25 for Males?
- What if below 20 Repetitions was associated with an increased risk of injury – Would that increase the risk of injury to the female? (What is the duty of care?)
- Would that be fair for two people who had to do the same job regardless of sex?
What is the purpose?

- Purpose of the testing – Setting standards
  - Male (38 years old) scores - 22 Repetitions

What if the PASS score was 25 for Males?
- Would that account for differences in age related strength levels?
What is the purpose?

- Purpose of the testing – Setting standards
  - Male scores (38 years old)– 22 Repetitions

What if the PASS scores were:
- under 25 years of age – 30 Repetitions
- 25-30 years of age– 25 Repetitions
- 31-39 years of age – 20 Repetitions

- Would that be fair for two people who had to do the same job regardless of age?
What is the purpose?

- Purpose of the testing – Setting standards
- What about Rank? Do all ranks do the same job?
What is the purpose?

- Purpose of the testing – Setting standards
- What about job tasks?
- Do all officers do the same job?
What is the purpose?

• Purpose of the testing – Setting standards
  • The purpose of the testing must be clearly understandable
PURPOSE OF TESTING – INJURY PREDICTION

• Entry standards:
  • Research has shown, police and army personnel with lower fitness standards more likely to be injured in training
PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

- Army Recruits
  - Measure was 20m Shuttle Run
    - Army standard = L7.5
    - Navy / AirForce = L6.5

PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

• Police Officer Recruits
  • Measure was 20m Shuttle Run

Non Injured (0) M=65.6 Shuttles
Injured (1) M=55.1 Shuttles
p<0.001

Orr, Schram et al., (Post review)
PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

- Police Officer Recruits
  - Measure was 20m Shuttle Run
    - $\ln(\text{inj}) = 1.644 - 0.045 \times \text{MSFT}$
    - So cut off point for MSFT is 51.9366 (Level 6.1 or 1040m)

<table>
<thead>
<tr>
<th>NIL INJ</th>
<th>INJ</th>
<th>Predicted</th>
<th>Percentage Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>159</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>49</td>
<td>7</td>
</tr>
</tbody>
</table>

Overall Percentage: 75.8
PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

- Police Officer Recruits
  - Measure was 20m Shuttle Run

<table>
<thead>
<tr>
<th></th>
<th>GRAD (n = 330)</th>
<th>SEPPR (n = 28)</th>
<th>SEPFI (n = 18)</th>
<th>SEPAS (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSFT shuttles (no.)</td>
<td>52.75 ± 16.69</td>
<td>41.54 ± 10.74*</td>
<td>39.94 ± 13.03*</td>
<td>46.08 ± 11.19</td>
</tr>
</tbody>
</table>

* Significantly ($p < 0.05$) different from the GRAD group.

PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

- Police Officer Recruits
- Measure was 20m Shuttle Run

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pass n=81 Mean ± SD</th>
<th>Fail n=18 Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>28± 5</td>
<td>35 ± 9</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>178 ± 7</td>
<td>176 ± 8</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>85± 11</td>
<td>86 ± 19</td>
</tr>
<tr>
<td>Push-ups (repetitions)</td>
<td>48.67 ± 11.87**</td>
<td>37.39 ± 7.86</td>
</tr>
<tr>
<td>Sit-ups (repetitions)</td>
<td>44.17 ± 5.91**</td>
<td>40.50 ± 5.31</td>
</tr>
<tr>
<td>20-m MSFT (# shuttles)</td>
<td>61.20 ± 16.98**</td>
<td>49.33 ± 18.31</td>
</tr>
<tr>
<td>Vertical Jump Height (cm)</td>
<td>56.03 ± 8.86**</td>
<td>48.06 ± 7.54</td>
</tr>
</tbody>
</table>

†Significant differences at the p ≤ 0.01

PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

• Police Officer Recruits
  • Measure was 30-15 IFT
    • Non Injured (0) M=16.9
    • Injured (1) M=15.7
    • p<0.001

PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

- Police Officer Recruits
  - Measure was 30-15 Intermittent Fitness Test
    - \( \text{Ln(inj)} = 7.456 - 0.521 \times 30-15 \text{score} \)
    - So cut off point for 30-15 is 15.65

PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

- Police Officer Recruits
  - Measure was 30-15 Intermittent Fitness Test
  - Percent Injured vs. 30-15 IFT Score, 95% CI

### PURPOSE OF TESTING – INJURY PREDICTION (MET FITNESS)

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>log[Risk Ratio]</th>
<th>SE</th>
<th>Total</th>
<th>Total</th>
<th>Weight</th>
<th>IV, Random, 95% CI</th>
<th>Risk Ratio</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blacker 2008</td>
<td>0.8502</td>
<td>0.2697</td>
<td>2688</td>
<td>2664</td>
<td>6.3%</td>
<td>2.34 [1.38, 3.97]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hall 2017</td>
<td>0.8629</td>
<td>0.1347</td>
<td>610</td>
<td>302</td>
<td>16.3%</td>
<td>2.37 [1.82, 3.09]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jones 2017</td>
<td>0.9163</td>
<td>0.0208</td>
<td>28393</td>
<td>28713</td>
<td>34.1%</td>
<td>2.50 [2.40, 2.60]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knapik 2001</td>
<td>0.47</td>
<td>0.2069</td>
<td>169</td>
<td>161</td>
<td>9.5%</td>
<td>1.60 [1.07, 2.40]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knapik 2011</td>
<td>0.7227</td>
<td>0.2349</td>
<td>106</td>
<td>108</td>
<td>7.8%</td>
<td>2.06 [1.30, 3.26]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lisman 2013</td>
<td>0.5423</td>
<td>0.1505</td>
<td>430</td>
<td>428</td>
<td>14.4%</td>
<td>1.72 [1.28, 2.31]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rauh 2006</td>
<td>0.9555</td>
<td>0.3945</td>
<td>204</td>
<td>204</td>
<td>3.2%</td>
<td>2.60 [1.20, 5.63]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaffer 1999</td>
<td>1.1346</td>
<td>0.4599</td>
<td>272</td>
<td>267</td>
<td>2.4%</td>
<td>3.11 [1.26, 7.66]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaffer 2006</td>
<td>1.2892</td>
<td>0.2792</td>
<td>696</td>
<td>686</td>
<td>5.9%</td>
<td>3.63 [2.10, 6.27]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>33568</td>
<td></td>
<td></td>
<td>33533</td>
<td>100.0%</td>
<td>2.27 [1.96, 2.63]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: \( \tau^2 = 0.02 \); \( \chi^2 = 13.42 \), df = 8 (\( P = 0.10 \)); \( I^2 = 40\%

Test for overall effect: \( Z = 11.01 \) (\( P < 0.00001 \))

---

PURPOSE OF TESTING – INJURY PREDICTION (STRENGTH)

• Police Officer Recruits
  • Measure Grip Strength

43.18 ± 8.73 kg (26-69)

40.48 ± 8.15 kg (25-59)


(rs[219]=.126, p=0.63).
PURPOSE OF TESTING – INJURY PREDICTION (STRENGTH)

• Police Officer Recruits
  • Measure Grip Strength
  • Percentage of Recruits injured, by GS score, with 95% CI

PURPOSE OF TESTING – INJURY / ILLNESS PREDICTION (USING POWER)

• Police Officer Recruits
  • Measure was Vertical Jump
  • Percentage of Recruits *injured*, by VJ height, with 95% CI

PURPOSE OF TESTING – INJURY / ILLNESS PREDICTION (USING POWER)

• Police Officer Recruits
  • Measure was Vertical Jump
  • Percentage of Recruits reporting illness, by VJ height, with 95% CI

PURPOSE OF TESTING – INJURY / ILLNESS PREDICTION (USING POWER)

- Police Officer Recruits
  - Measure was Vertical Jump
  - Percentage of Recruits reporting illness &/or injury, by VJ height, with 95% CI

PURPOSE OF TESTING – INJURY PREDICTION (USING MUSCLE ENDURANCE)

• Police Officer Recruits
  • Measure was Push Ups
  • Percentage of Recruits injured, by PU score, with 95% CI

Orr RM, Stewart M, Pope R, Stierli M, and Hinton B.
PURPOSE OF TESTING – INJURY PREDICTION (USING MUSCLE ENDURANCE)

- Police Officer Recruits
  - Measure was Push Ups

Pass rate for police recruits = 25 PU

25.6% did not achieve 25 PU (n=56)

Of those 53.7% sustained injury

PURPOSE OF TESTING – INJURY PREDICTION / SURVIVABILITY

• Special Weapons and Tactics Teams
PURPOSE OF TESTING – INJURY PREDICTION / SURVIVABILITY

• Special Weapons and Tactics Teams
  • Measure was Push Ups

Spearman’s Correlation
($r_s = 0.412, p = 0.009$).

PURPOSE OF TESTING – INJURY PREDICTION / SURVIVABILITY

• Special Weapons and Tactics Teams
  • Measure was Lift and Carry Task

Spearman’s Correlation
\( r_s = -0.494, \ p = 0.010 \).

Aim: To determine whether performance on a loaded explosive occupational task (the Urban Rush), as well as longer 2.4 km and 10 km load carriage tasks were indicative of candidate success on a specialist tactical response police selection course.
PURPOSE OF TESTING – INJURY PREDICTION / SURVIVABILITY

- Special Weapons and Tactics Teams
  - Loaded marches

<table>
<thead>
<tr>
<th>Anthropometric Data/Performance Measure</th>
<th>Successful Applicants Mean ± Standard Deviation</th>
<th>Unsuccessful Applicants Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) *</td>
<td>30.64 ± 4.97</td>
<td>34.43 ± 4.54</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>181.36 ± 5.35</td>
<td>187.43 ± 4.58*</td>
</tr>
<tr>
<td>Body Weight (kg) *</td>
<td>85.36 ± 6.65</td>
<td>95.86 ± 7.45**</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.94 ± 1.49</td>
<td>27.27 ± 1.46</td>
</tr>
<tr>
<td>Loaded BMI (kg/m²)</td>
<td>33.33 ± 1.75</td>
<td>34.02 ± 1.38</td>
</tr>
<tr>
<td>Urban Rush (mins)</td>
<td>1.87 ± 0.16</td>
<td>1.86 ± 0.15</td>
</tr>
<tr>
<td>2.4 km Loaded March (mins)</td>
<td>13.64 ± 0.92</td>
<td>15.29 ± 1.60*</td>
</tr>
<tr>
<td>10km Loaded March (mins) *</td>
<td>86.03 ± 2.26</td>
<td>87.86 ± 2.34</td>
</tr>
</tbody>
</table>

PURPOSE OF TESTING – OCCUPATIONAL CAPABILITY

• Based on capability rather than gender or age
PURPOSE OF TESTING – OCCUPATIONAL CAPABILITY

- Based on capability rather than sex or age
- What is needed to complete key tasks

http://images.canberratimes.com.au/2012/03/14/3129265/1554010-420x0.jpg
PURPOSE OF TESTING – OCCUPATIONAL CAPABILITY

- Police Officer Recruits
  - Measure Grip Strength
  - Defensive Tactics

43.68 ± 8.36 kg (25-67)
40.00± 7.73kg (28-62)

PURPOSE OF TESTING – OCCUPATIONAL CAPABILITY

- Police Officer Recruits
  - Measure Grip Strength
  - Defensive Tactics

'Old, unfit, overweight' officer convicted of running down teen with police car

By Joanna Menagh and Evan Morgan Graham
Updated 28 Oct 2019 7:03pm AEDT

A police officer who was filmed driving into an 18-year-old man in Perth's south-east last year, knocking him down and sending him to hospital, has been found

dashcam footage captured William Farmer being hit by the police car
PURPOSE OF TESTING – OCCUPATIONAL CAPABILITY

- Police Officer Recruits
  - Measure Grip Strength
  - Marksmanship / Shooting

43.22 ± 8.04 kg (25-67)
34.67 ± 5.94 kg (28-51)

PURPOSE OF TESTING – OCCUPATIONAL CAPABILITY

• Police Officer Recruits
  • Measure Grip Strength
  • Marksmanship

PURPOSE OF TESTING – OCCUPATIONAL CAPABILITY

• Incumbent Police Officer
  • Measure Grip Strength
  • Marksmanship / Shooting

<table>
<thead>
<tr>
<th>Static Score</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static Score</td>
<td>-</td>
<td>0.314</td>
</tr>
<tr>
<td>Dynamic Scenario</td>
<td>0.314</td>
<td>-</td>
</tr>
<tr>
<td>Positive Identification Scenario</td>
<td>0.281</td>
<td>0.177</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shuttle Run</th>
<th>Vertical Jump (cm)</th>
<th>Grip Strength (kg)</th>
<th>Leg Dyno (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static Score</td>
<td>0.528 **</td>
<td>0.322</td>
<td>-0.001</td>
</tr>
<tr>
<td>Dynamic Scenario</td>
<td>0.170</td>
<td>-0.022</td>
<td>-0.367 *</td>
</tr>
<tr>
<td>Positive Identification Scenario</td>
<td>0.009</td>
<td>0.221</td>
<td>0.040</td>
</tr>
<tr>
<td>Total Score</td>
<td>0.220</td>
<td>0.255</td>
<td>-0.129</td>
</tr>
</tbody>
</table>

** Correlation was significant at the 0.01 level (2-tailed).  * Correlation was significant at the 0.05 level (2-tailed).

PURPOSE OF TESTING – GENERAL HEALTH

- Considers gender and age
- Predictor of mortality
PURPOSE OF TESTING – GENERAL HEALTH

• Police Officer Recruits v Incumbent Officers
  – Measure was 1.5 mi run time

### PURPOSE OF TESTING – GENERAL HEALTH

<table>
<thead>
<tr>
<th>Task</th>
<th>HR Mean ± SD (Range) BPM</th>
<th>%HR Max Mean ± SD (Range) %</th>
<th>RR Mean ± SD (Range) Breaths/minute</th>
<th>Duration Mean ± SD (Range) Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check bonafides</td>
<td>86±12.79 (58-204)</td>
<td>47±7.18 (39-111)</td>
<td>23±5.60 (10-39)</td>
<td>14±11.05 (1-46)</td>
</tr>
<tr>
<td>Driving urgently</td>
<td>91±17.20 (48-198)</td>
<td>50±9.35 (40-115)</td>
<td>24±6.12 (12-39)</td>
<td>5±5.84 (1-38)</td>
</tr>
<tr>
<td>Attending a concern for welfare</td>
<td>87±10.44 (40-198)</td>
<td>47±6.41 (53-111)</td>
<td>22±5.52 (18-27)</td>
<td>11±10.43 (1-44)</td>
</tr>
<tr>
<td>Attending a domestic incident</td>
<td>92±15.97 (40-214)</td>
<td>49±8.78 (40-116)</td>
<td>22±3.83 (16-28)</td>
<td>23±30.09 (2-134)</td>
</tr>
</tbody>
</table>

PURPOSE OF TESTING – GENERAL HEALTH

• The normative population?
  • Is the tactical population the same?

Push Up performance of male police officers

PURPOSE OF TESTING – GENERAL HEALTH

• One size – fits no one: Differences between officers from 2 different LEA

Comparing Officers from LEA1 and LEA2

<table>
<thead>
<tr>
<th></th>
<th>LEA1</th>
<th>LEA2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>39.31</td>
<td>37.84</td>
</tr>
<tr>
<td>Weight (kg)*</td>
<td>55.69</td>
<td>61.53</td>
</tr>
<tr>
<td>Push-up (reps)*</td>
<td>41.96</td>
<td>36.9</td>
</tr>
<tr>
<td>Sit-up (reps)*</td>
<td>40.64</td>
<td>52.81</td>
</tr>
<tr>
<td>Vertical Jump (cm)*</td>
<td>61.53</td>
<td>41.52</td>
</tr>
<tr>
<td>VO2 Max (ml/kg/min)*</td>
<td>85.27</td>
<td>88.6</td>
</tr>
</tbody>
</table>

PURPOSE OF TESTING – GENERAL HEALTH

• One size – fits no one: Differences between officers from 2 different LEA

Comparing Male Officers from LEA1 and LEA2

<table>
<thead>
<tr>
<th></th>
<th>LEA1</th>
<th>LEA2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>39.43</td>
<td>37.92</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>87.46</td>
<td>88.8</td>
</tr>
<tr>
<td>Push-up (reps)</td>
<td>57.76</td>
<td>42.16</td>
</tr>
<tr>
<td>Sit-up (reps)</td>
<td>40.16</td>
<td>36.96</td>
</tr>
<tr>
<td>Vertical Jump (cm)</td>
<td>62.63</td>
<td>53.06</td>
</tr>
<tr>
<td>VO2 Max (ml/kg/min)</td>
<td>41.44</td>
<td>34.1</td>
</tr>
</tbody>
</table>

PURPOSE OF TESTING – RESEARCH (VALIDATE TRAINING)

- To review the effectiveness of training through evidence based research
  - Data collected pre- and post- training programs
  - Subjects: 90 male (n = 70) and female (n = 20) police cadets aged from 21 to 44 years (27.4 ± 5.9 years) from US Police Department
  - 2 programs
    1. Random, “workout-of-the-day,” 4 classes (n = 65)
    2. Periodised, 1 class (n = 25)
PURPOSE OF TESTING – RESEARCH (VALIDATE TRAINING)

• To review the effectiveness of training through evidence based research

PURPOSE OF TESTING – RESEARCH (VALIDATE TRAINING)

• To review the effectiveness of training through evidence based research

PURPOSE OF TESTING – RESEARCH (VALIDATE TRAINING)

• To review the effectiveness of training through evidence based research

TAKE HOME MESSAGES

• It is vital you know WHY you are doing / designing a fitness assessment framework – and educate (and continue to educate) the officers at all levels

• Standards need to consider this reason and take into account the intent of the assessment (e.g. fitness / health or occupational performance)

• One size assessments do not fill all – Each LEA may have specific needs
How Current, Relevant, and Valid Are Our “Standards?”

Joseph Dulla
Los Angeles Sheriff’s Department, Los Angeles USA:
Lt. Joseph Dulla

Los Angeles County Sheriff’s Department, Recruit Training Unit

• 39+ Year first responder
  • EMT
  • Lifeguard
• 31+ Years LASD
  • Custody
  • Patrol
  • Investigative
  • Supervision, management, training & academy

• Research and peer-reviewed work

• Workgroups & taskforces
  • Local LA County HPO, JTA, physical abilities, return to work
  • State-CA POST
  • National-NSCA-TSAC, US DOJ-COPS
  • International TRU
REMOVED UNTIL CLEARED
Fitness Testing in LASD – Academic Perspective

Robert Lockie
California State University, Fullerton, USA:
DR. ROBERT LOCKIE

• PhD in Strength and Conditioning and Biomechanics – University of Technology, Sydney, Australia

• Assistant Professor in Strength and Conditioning at California State University, Fullerton (CSUF)

• Past positions: University of Newcastle (Australia) and California State University, Northridge

• Tactical Strength and Conditioning Facilitator (TSAC-F)

• Sports, athletic performance, strength and conditioning researcher for ~18 years

• Tactical strength and conditioning research for ~3 years

• CSUF Tactical Research: 34 published or accepted peer-reviewed manuscripts, 10 manuscripts under review, 73 conference abstracts/presentations
Fitness Testing in LASD – Academic Perspective

Athlete performance testing
- Identify and assess important fitness qualities for sport
- Fitness testing → want best performance!

Law enforcement fitness testing is different
- Identify and assess important fitness qualities for the job
- Recruits vs. incumbent
- Initial hiring vs. academy exit examination vs. fitness assessments
- How is the information being used?
Why?

Why is the fitness testing/assessment being done?

- Tracking fitness from initial hiring to start of academy
- Tracking progress during academy
- Are there typical fitness qualities of recruits who do not graduate academy?

Good intentions

- Better job performance
- Better health outcomes

Punitive

- Disciplinary measures
- Reassignment
- Resistance to fitness testing/assessment
General Fitness vs. Job-Specific Fitness

General fitness: qualities that could relate to job performance and health
• Muscular endurance (push-ups, sit-ups), lower-body power (vertical jump), aerobic fitness (1.5 mile run, multistage fitness test)
• General health: blood pressure, waist circumference, body mass index
• Can be limited by time, equipment, tester and recruit/officer abilities

Job-specific fitness: tests that relate to tasks completed by officers
• Exit examinations
• Occupational physical ability tests
• Obstacle courses, fence climbs, body/casualty drags
Article

Physical Fitness Characteristics That Relate to Work Sample Test Battery Performance in Law Enforcement Recruits

Robert G. Lockie 1,*, J. Jay Dawes 2, Katherine Balfany 1, Ciara E. Gonzales 1, Maria M. Beitzel 1, Joseph M. Dulla 3,Φ and Robin M. Orr 4,Φ

PT500

• Push-ups in 60 s
• Sit-ups in 60 s
• Mountain climbers in 60 s
• Pull-ups
• 200-yard run
• 1.5-mile run

Work Sample Test Battery

• 99-yard obstacle course
• 165-lb body drag
• 6-foot chain link fence climb
• 6-foot solid wall fence climb
• 500-yard run
<table>
<thead>
<tr>
<th>Activity</th>
<th>99-yard Obstacle Course</th>
<th>Body Drag</th>
<th>Chain Link Fence Climb</th>
<th>Solid Wall Fence Climb</th>
<th>500-yard Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push-ups</td>
<td>r 0.125</td>
<td>0.024</td>
<td>0.094</td>
<td>-0.053</td>
<td>-0.128*</td>
</tr>
<tr>
<td></td>
<td>p 0.050</td>
<td>0.710</td>
<td>0.143</td>
<td>0.412</td>
<td>0.045</td>
</tr>
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</tr>
<tr>
<td></td>
<td>p 0.001</td>
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<td>0.006</td>
<td>0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mountain Climbers</td>
<td>r -0.126</td>
<td>0.049</td>
<td>-0.020</td>
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<td></td>
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<tr>
<td>Pull-ups</td>
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<tr>
<td>201-m Run</td>
<td>r 0.127*</td>
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<td>0.029</td>
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<tr>
<td>2.4-km Run</td>
<td>r 0.253*</td>
<td>0.011</td>
<td>0.131*</td>
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<td>0.574*</td>
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<tr>
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Considerations

It is not cause and effect
• Physical fitness is an important part of job-specific performance, but does not always provide a direct measure of this

This data relates to recruits
• Would incumbent officers be different?
• Have to complete these tasks to graduate academy; may not have to when on-duty (tactical considerations)

However, can be great value in fitness assessment data between researchers and law enforcement staff with correct application
Application of Fitness Assessment Data

Objectivity
• Don’t forget that the numbers are numbers people!

Assistance with data interpretation
• What do the numbers mean?

Academics can help the agency interpret fitness testing data to impact future decisions

Academics can provide some guidance as to ‘why’
• Why did a particular academy class have greater attrition?
Example – LASD Testing Protocols

Validated Physical Ability Test (VPAT)

- Push-ups in 60 s
- Sit-ups in 60 s
- Arm ergometer revolutions in 60 s
- 75-yard pursuit run
- 1.5 mile run
Example – LASD Testing Protocols

Wanted to investigate the use of the 20-m Multistage Fitness Test (MSFT; beep test)
• Could be done indoors
• Required less space
• External pacing
• Could test large number of recruits relatively quickly and easily

When and how could this be done?
• Staff and time issues
• Week prior to academy when recruits typically visited with HR
Relationship Between the 20-m Multistage Fitness Test and 2.4-km Run in Law Enforcement Recruits

Robert G. Lockie, J. Jay Dawes, Matthew R. Moreno, Karly A. Cesario, Katherine Balfany, Michael Stierli, Joseph M. Dulla, and Robin M. Orr

Department of Kinesiology, California State University Fullerton, Fullerton, California; Department of Health Sciences, University of Colorado-Colorado Springs, Colorado Springs, Colorado; Sydney Police Center, Surry Hills, New South Wales, Australia; Recruit Training Unit, Training Bureau, Los Angeles County Sheriff's Department, Los Angeles, California; and Tactical Research Unit, Bond University, Robina, Queensland, Australia

The Influence of Physical Fitness on Reasons for Academy Separation in Law Enforcement Recruits

Robert G. Lockie, Katherine Balfany, Ashley M. Bloodgood, Matthew R. Moreno, Karly A. Cesario, Joseph M. Dulla, J. Jay Dawes and Robin M. Orr

WAIST CIRCUMFERENCE AND WAIST-TO-hip RATIO IN LAW ENFORCEMENT AGENCY RECRUITS: RELATIONSHIP TO PERFORMANCE IN PHYSICAL FITNESS TESTS

Robert G. Lockie, Tomas R. Ruvalcaba, Michael Stierli, Joseph M. Dulla, J. Jay Dawes, and Robin M. Orr

Department of Kinesiology, California State University Fullerton, Fullerton, California; Tactical Research Unit, Bond University, Robina, Queensland, Australia; Sydney Police Center, Surry Hills, New South Wales, Australia; Recruit Training Unit, Training Bureau, Los Angeles County Sheriff's Department, Los Angeles, California; and Department of Health Sciences, University of Colorado-Colorado Springs, Colorado Springs, Colorado

The effects of aerobic fitness on day one physical training session completion in law enforcement recruits

New VPAT (https://careers.lasd.org/physical-ability-test/)

- Push-ups in 60 s
- Sit-ups in 60 s
- 75-yard pursuit run
- MSFT

Would not have happened without collaborative effort between LASD and academics
# Example – LASD Academy Attrition

<table>
<thead>
<tr>
<th></th>
<th>GRAD (n = 330)</th>
<th>SEP: Personal Reasons (n = 28)</th>
<th>SEP: Fitness or Injury (n = 18)</th>
<th>SEP: Academic or Scenario Failure (n = 25)</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>26.67 ± 5.19</td>
<td>29.35 ± 8.02</td>
<td>29.59 ± 6.88</td>
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<td>Height (m)</td>
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<td>Body Mass (kg)</td>
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<td>75PR (s)</td>
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<td>VJ (cm)</td>
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<td>MSFT shuttles (no.)</td>
<td>52.75 ± 16.69</td>
<td>41.54 ± 10.74*</td>
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Case Study – Waist Circumference

The full weight of the law: Texas DPS to start tracking troopers' waistlines

Some are concerned the new program will place more of a burden on older troopers, but the department says the changes are to ensure the officers' health.

Members of the Tarrant County Sheriff's Office Honor Guard salute during the opening ceremony at the INSPIRE 2019 conference in San Antonio, Texas. (Jae C. Hong / Associated Press)
# Abdominal Obesity Measurement Guidelines

<table>
<thead>
<tr>
<th>Organization</th>
<th>Measurement used</th>
<th>Definition of abdominal obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Heart Association, National Heart, Lung and Blood Institute (10)</td>
<td>Waist circumference</td>
<td>Women: &gt; 88 cm (35 inches), Men: &gt; 102 cm (40 inches)</td>
</tr>
<tr>
<td>International Diabetes Federation (11)</td>
<td>Waist circumference</td>
<td>Women: &gt; 80 cm (31.5 inches), Men: &gt; 90 cm (35.5 inches) Different cut-points for different ethnic groups</td>
</tr>
<tr>
<td>World Health Organization (12)</td>
<td>Waist-to-hip ratio</td>
<td>Women: &gt; 0.85, Men: &gt; 0.9</td>
</tr>
</tbody>
</table>

https://www.hsph.harvard.edu/obesity-prevention-source/obesity-definition/abdominal-obesity/
### Classification of Overweight and Obesity by BMI, Waist Circumference, and Associated Disease Risks

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>Obesity Class</th>
<th>Disease Risk* Relative to Normal Weight and Waist Circumference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td></td>
<td>Women 88 cm (35 in) or less</td>
</tr>
<tr>
<td>18.5–24.9</td>
<td>Normal</td>
<td>Men 102 cm (40 in) or less</td>
</tr>
<tr>
<td>25.0–29.9</td>
<td>Overweight</td>
<td>Increased</td>
</tr>
<tr>
<td>30.0–34.9</td>
<td>I</td>
<td>High</td>
</tr>
<tr>
<td>35.0–39.9</td>
<td>II</td>
<td>Very High</td>
</tr>
<tr>
<td>40.0 +</td>
<td>III</td>
<td>Extremely High</td>
</tr>
</tbody>
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* Disease risk for type 2 diabetes, hypertension, and CVD.
+ Increased waist circumference also can be a marker for increased risk, even in persons of normal weight.

WAIST CIRCUMFERENCE AND WAIST-TO-HIP RATIO IN LAW ENFORCEMENT AGENCY RECRUITS: RELATIONSHIP TO PERFORMANCE IN PHYSICAL FITNESS TESTS

ROBERT G. LOCKIE, TOMAS R. RUVALCABA, MICHAEL STIERLI, JOSEPH M. DULLA, J. JAY DAWES, AND ROBIN M. ORR

1Department of Kinesiology, California State University, Fullerton, Fullerton, California; 2Tactical Research Unit, Bond University, Robina, Queensland, Australia; 3Sydney Police Centre, Surry Hills, New South Wales, Australia; 4Recruit Training Unit, Training Bureau, Los Angeles County Sheriff’s Department, Los Angeles, California; and 5Department of Health Sciences, University of Colorado-Colorado Springs, Colorado Springs, Colorado

Less push-up repetitions
Less sit-up repetitions
Lesser vertical jump
Slower 75-yard pursuit run
Less beep test shuttles
Greater waist circumference → more likely to perform poorer in fitness assessments
Greater waist circumference → greater cardiovascular risk

**BUT**

What are the officer’s current job tasks?
Is job performance negatively impacted?
What’s the difference between a 40.5-inch waist vs. a 39.5-inch waist?
Challenges

Testing conditions
- Indoors and outdoors
- Different environmental conditions and testing surfaces
- This can affect the data you collect!
- Record testing conditions, location, temperature if required

Data collection
- Missing information, consistency between raters

Communication
- Between and within agency

Publication review process
Law enforcement staff and academics can work collaboratively for beneficial outcomes

- Evidence-based practice and decision-making
- Advocate for positive change
- Understand differences between general and job-specific fitness – and the implications of this!

Understand the important outcomes for law enforcement staff and academics – and how these can support each other

- Publications provide evidence for change in policies and practices – or support current practices
- Help provide answers to questions you may have
- Support staff → academics and their students → community engagement
The Colorado State Patrol Project
2014-present

Jay Dawes
Oklahoma State University, Stillwater, USA.
• Jay Dawes, PhD, CSCS*D, TSAC-F, FNSCA
• Assistant Professor- Applied Exercise Science
• Department of Health and Human Performance, Oklahoma State University, Stillwater, OK.
• **Research Focus:** Strength and Conditioning for the Occupational Athlete
• Email: jay.dawes@okstate.edu
Training Academy

<table>
<thead>
<tr>
<th>Variable</th>
<th><strong>Pass</strong> n=81</th>
<th><strong>Fail</strong> n=18</th>
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<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>28.32 ± 5.34†</td>
<td>35.5 ± 9.36</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>177.95 ± 6.60</td>
<td>176.30 ± 8.40</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>84.70 ± 11.31</td>
<td>85.98 ± 19.48</td>
</tr>
<tr>
<td>Push-ups (repetitions)</td>
<td>48.67 ± 11.87†</td>
<td>37.39 ± 7.86</td>
</tr>
<tr>
<td>Sit-ups (repetitions)</td>
<td>44.17 ± 5.91†</td>
<td>40.50 ± 5.31</td>
</tr>
<tr>
<td>20-m MSFT (# shuttles)</td>
<td>61.20 ± 16.98†</td>
<td>49.33 ± 18.31</td>
</tr>
<tr>
<td>Vertical Jump Height (cm)</td>
<td>56.03 ± 8.86†</td>
<td>48.06 ± 7.54</td>
</tr>
</tbody>
</table>

Table I: Descriptive data for academy cadets
†Significant differences at the p ≤ 0.01
### Table II. Characteristics of cadets by sex

<table>
<thead>
<tr>
<th>Variable</th>
<th>Female Cadets</th>
<th>Male Cadets</th>
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<tr>
<td></td>
<td>Pass n=6</td>
<td>Fail n=4</td>
</tr>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>25.66 ± 2.94</td>
<td>25.25 ± 1.89</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>167.64 ± 4.01</td>
<td>167.01 ± 5.61</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>73.86 ± 10.73**††</td>
<td>62.04 ± 10.61</td>
</tr>
<tr>
<td>Push-ups (repetitions)</td>
<td>37.50 ± 7.04**†††</td>
<td>29.75 ± 3.20</td>
</tr>
<tr>
<td>Sit-ups (repetitions)</td>
<td>43.16 ± 10.05**††</td>
<td>38.75 ± 4.57</td>
</tr>
<tr>
<td>20-m MSFT (# shuttles)</td>
<td>39.67 ± 11.46**††</td>
<td>34.5 ± 4.65</td>
</tr>
<tr>
<td>Vertical Jump (cm)</td>
<td>41.91 ± 3.03</td>
<td>41.53 ± 0.91</td>
</tr>
</tbody>
</table>

* Significant differences at the p ≤ 0.05
** Significant differences at the p ≤ 0.01
†† Small Effect Size (ES)
††† Moderate Effect Size (ES)
††† Large Effect Size (ES)

Notably, all recorded injuries occurred during the first 19 days of the 189 day training course for female recruits and during the first 21 days of the course for male recruits.

Academy Completion

- Lowest 15% = 44% Failures
- Cut Score = 33 push-ups
- Model Accuracy = 47%
Academy Completion

- Lowest 15% = 50% Failures
- Cut Score = 39 shuttles
- Model Accuracy = 62%

**Beep Test Score Calculator**

To calculate your predicted VO\textsubscript{2max} from your 20 meter shuttle run test result, enter your level and number of shuttles for that level in the boxes below, and then click the "calculate" button. For a listing of the number of shuttles for each level, go here.

For example, if you scored 8-5 on the beep test, you would enter 8 in the first box, and 5 in the second.

Enter your Age*: 43
Sex:  Male  Female

Enter your level (e.g., 8): 9
Enter your number of shuttles (e.g., 5): 3

Press the button to see your predicted VO\textsubscript{2max} score:  Calculate

Your result (ml/kg/min):  44 3

Rating:  Good

* rating is only based on ages > 17 years
- ≤ 39 shuttles and ≤ 32 PU
- Model Accuracy = 75%

<table>
<thead>
<tr>
<th>Shuttle #</th>
<th>PU</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>31</td>
<td>Yes</td>
</tr>
<tr>
<td>30</td>
<td>31</td>
<td>Yes</td>
</tr>
<tr>
<td>31</td>
<td>25</td>
<td>Yes</td>
</tr>
<tr>
<td>33</td>
<td>26</td>
<td>Yes</td>
</tr>
<tr>
<td>36</td>
<td>42</td>
<td>Yes</td>
</tr>
<tr>
<td>38</td>
<td>31</td>
<td>Yes</td>
</tr>
<tr>
<td>38</td>
<td>39</td>
<td>Yes</td>
</tr>
<tr>
<td>39</td>
<td>32</td>
<td>Yes</td>
</tr>
</tbody>
</table>
RISK STRATIFICATION

HIGH

MEDIUM

LOW
### CADET Push-ups Shuttle # FAIL

<table>
<thead>
<tr>
<th>CADET</th>
<th>Push-ups</th>
<th>Shuttle #</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>8</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>21</td>
<td>8</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>15</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>17</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>31</td>
<td>18</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>21</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>24</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>33</td>
<td>37</td>
<td>Yes</td>
</tr>
<tr>
<td>9</td>
<td>25</td>
<td>46</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>31</td>
<td>49</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Predicted = 80% Failures**

**Model Accuracy = 100%**

Dawes et al (In process)
Practical Application

• Holmes and Kornhauser (2018)
  • Assessment and risk profile
    • (suggested minimum standard 39 shuttles and 32 pushups)
  • “Zero week”
    • incorporating teaching and movement coaching
  • 0% attrition based on physical fitness in last 5 academies

Incumbent Officer Testing
Physical Fitness Characteristics of High vs. Low Performers on an Occupationally Specific Physical Agility Test for Patrol Officers

J. Jay Dawes,1 Keston Lindsay,2 Jennifer Bero,1 Craig Elder,1 Charlie Kornhauser,3 and Ryan Holmes4
1Department of Health Sciences, University of Colorado, Colorado Springs, Colorado Springs, Colorado; and 2Colorado State Highway Patrol, Training Academy, Lakewood, Colorado

- N =495 FT Patrol Officers
- Fitness Battery:
  - HGD, LBD, 1min. Push-ups and sit-ups, Vertical Jump, Beep Test
- Occupational Assessment
  - Physical Agility Test (PAT)

Why measure Isometric Strength?

Relationships Between Absolute and Relative Strength and Power in Male Police Officers of Varying Strength Levels

J. Jay Dawes¹ - Robert G. Lockle² - Charles L. Kornhauser³ - Ryan J. Holmes³ - Robin M. Orr⁴

Received: 3 August 2019 / Accepted: 31 August 2019
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Fig. 1 Differences in CMJ (cm) height by quartile (LBDa)

Fig. 4 Differences in CMJ (cm) height by quartile (LBDr)
Does body mass index influence the physiological and perceptual demands associated with defensive tactics training in state patrol officers?

J.J. DAWES1, C.L. KORNHAUSER2, D. CRESPON3, C.L. ELDER1, K. LINDSAY1, R.J. HOLMES1

n = 24 Full-time male officers, Randomly selected

Unmarked Basketball Court, Wooden Floor,
Pass = 70%
Relationship Between Fitness and Occupational Tasks

N=74 (69 males, 5 females)

Table 2: Correlations between Occupational Performance Measures and Fitness Tests

<table>
<thead>
<tr>
<th></th>
<th>Vertical Jump (cm.)</th>
<th>Grip Strength (kg)</th>
<th>Leg/back Dynamometer (kg)</th>
<th>Push-ups (#reps)</th>
<th>Sit-ups (#reps)</th>
<th>20m MSFT (# Shuttles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Yard Sprint (sec)</td>
<td>-.779†</td>
<td>-.232*</td>
<td>-.303†</td>
<td>-.620†</td>
<td>-.629†</td>
<td>-.553†</td>
</tr>
<tr>
<td>20 Yard Sprint (sec)</td>
<td>-.806†</td>
<td>-.264*</td>
<td>-.310†</td>
<td>-.620†</td>
<td>-.620†</td>
<td>-.554†</td>
</tr>
<tr>
<td>Fence Jump w/Run-up</td>
<td>-.614†</td>
<td>_</td>
<td>_</td>
<td>-.415†</td>
<td>-.459†</td>
<td>-.354†</td>
</tr>
<tr>
<td>Victim Drag</td>
<td>-.619†</td>
<td>-.253</td>
<td>-.290*</td>
<td>-.456†</td>
<td>-.536†</td>
<td>-.291†</td>
</tr>
</tbody>
</table>

### Relationship Between Fitness and Occupational Tasks

<table>
<thead>
<tr>
<th>Measure</th>
<th>FIT</th>
<th>LESS FIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>27.75</td>
<td>32.34</td>
</tr>
<tr>
<td>Push-ups (#)</td>
<td>46.47</td>
<td>49.14</td>
</tr>
<tr>
<td>Sit-ups (#)</td>
<td>44.49</td>
<td>40.26</td>
</tr>
<tr>
<td>Vertical Jump (cm)</td>
<td>53.87</td>
<td>59.42</td>
</tr>
<tr>
<td>P:W ratio (watts)</td>
<td>40.28</td>
<td>59.24</td>
</tr>
<tr>
<td>20mMSFT</td>
<td>40.26</td>
<td>63.69</td>
</tr>
</tbody>
</table>

Dawes et al, Manuscript in process

trud.bond.edu.au
Relationship Between Fitness and Occupational Tasks

![Graph showing the relationship between fitness levels and occupational tasks]

- 10 YRD SPRINT (sec): FIT = 2.15, LESS FIT = 2.45
- 20YRD SPRINT (sec): FIT = 3.64, LESS FIT = 4.2
- FENCE JUMP* (sec): FIT = 2.69, LESS FIT = 4.31
- FENCE JUMP W/ SPRINT (sec): FIT = 4.76, LESS FIT = 6.73
- VICTIM DRAG (sec): FIT = 6.43, LESS FIT = 8.45
- GET-UP* (sec): FIT = 2.34, LESS FIT = 3.25

$p \leq .01$

Dawes et al, Manuscript in process
# Incumbent Officers

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Jump (in)</td>
<td>16-21</td>
</tr>
<tr>
<td>Push-ups (reps)</td>
<td>46-57</td>
</tr>
<tr>
<td>Sit-ups (reps)</td>
<td>40-46</td>
</tr>
<tr>
<td>20m MSFT (shuttles)</td>
<td>40-57</td>
</tr>
</tbody>
</table>
Key Points

• Physical fitness is important in relation to health, fitness and occupational performance.
• Fitness testing and assessment data can be used to help predict potential injury among cadets and occupational performance among officers
• “Cut scores vs Guidelines” depends on your agencies needs and goals
Understanding Physical Fitness and Employment Standards

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Joseph Dulla: jdulla@sandiego.edu
Robert Lockie: rlockie@fullerton.edu
Jay Dawes: jay.dawes@okstate.edu