Australian Tactical Loads and their Operational Impacts

Dr Rob Orr (PhD, PHTY, BFET, TSAC-F, ADFPTS)

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https://bond.edu.au/tru
Background

• From the early Assyrian spearman of antiquity (circa 800 B.C.), soldiers have been required to carry external loads consisting of weaponry, equipment and food (Orr, 2010; Knapick et al., 2012:2004)

• Downstream effects of these loads have been shown to impact on the tactics of warfare, cause injury and reduce fighting force size (Lee, 2007; Breen, 2002; Lothian, 1921)
HISTORICAL CONTEXT – MILITARY

(Orr, 2010; Orr et al., 2015)
CURRENT CONTEXT – AUSTRALIAN ARMY

On Operations (2001-2010)

• PO loads
  • $M = 28.4 \pm 10.0 \text{ kg}$
    • heaviest mean load in 2008 ($M = 36.9 \pm 10.8 \text{ kg}$)

• MO loads
  • $M = 56.7 \pm 15.3 \text{ kg}$
    • heaviest mean load in 2009 ($M = 65.1 \pm 16.3 \text{ kg}$)

• OVERALL loads
  • $47.7 \pm 21.0 \text{ kg}$, (mean range over 10 years = 40.7 kg to 50.9 kg),

(Orr et al., 2015)
CURRENT CONTEXT – AUSTRALIAN ARMY

• Approximate relative load carried by Roman Legionnaires = 56%
• Australian Soldiers in East Timor = 56%
• US Soldiers in Afghanistan = 57%
ABSOLUTE VS RELATIVE LOADS

• Currently female soldiers carry lighter absolute loads than male soldiers but only slightly heavier relative loads

  **ABSOLUTE LOADS**
  
  FEMALE: $M = 26.4$ kg
  
  MALE: $M = 39.0$ kg
  
  $p = .045$

  **RELATIVE LOADS**
  
  FEMALE: $M = 43\%$
  
  MALE: $M = 47\%$
  
  $p = .55$

ABSOLUTE VS RELATIVE LOADS

• Currently lighter soldiers carry the same absolute loads as heavier soldiers but heavier relative loads

ABSOLUTE LOADS

Light 20%: $M = 34.7$ kg

Heavy 20%: $M = 35.7$ kg

$\text{p} = .902$

RELATIVE LOADS

Light 20%: $M = 49\%$

Heavy 20%: $M = 36\%$

$\text{p} = .0509$

HISTORICAL CONTEXT – LEO

[Images of historical police officers and equipment]

http://2.bp.blogspot.com/-xH6IULRfIIG/u/1eI/EgA/AAAAAAAA/p35/yapn_ibtE/s1600/Curious+Black+%26+White+Photographs+of+The+Police+Officers+from+1890–1930+(28).jpg


https://bond.edu.au/tru
HISTORICAL CONTEXT – LEO

- Police are becoming Christmas trees

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https://bond.edu.au/tru
HISTORICAL CONTEXT - LEO

- Increasing levels of threat
### HISTORICAL CONTEXT – AUSTRALIAN LEO

<table>
<thead>
<tr>
<th>ILAV type (A-C) &amp; Normal station wear (N)</th>
<th>ILAV Weight (kg)</th>
<th>Duty load Complete (kg)</th>
<th>Total load including officer weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.12 ± 0.65*</td>
<td>11.53 ± 0.77‡</td>
<td>88.03 ± 20.49</td>
</tr>
<tr>
<td>B</td>
<td>3.54 ± 0.70*</td>
<td>11.01 ± 1.01‡</td>
<td>87.51 ± 20.60</td>
</tr>
<tr>
<td>C</td>
<td>3.24 ± 0.48*</td>
<td>10.77 ± 1.16‡</td>
<td>87.27 ± 20.66</td>
</tr>
<tr>
<td>N</td>
<td>NA</td>
<td>8.69 ± 0.68</td>
<td>85.19 ± 20.24</td>
</tr>
</tbody>
</table>

* Significantly different (p<0.05) between vests:
‡ Significantly different (p<0.001) from normal station wear

(Orr et al., 2016)
CURRENT CONTEXT – AUSTRALIAN LEO

<table>
<thead>
<tr>
<th>ILAV type</th>
<th>FEMALE ILAV + Duty Loads (kg)</th>
<th>MALE ILAV + Duty Loads (kg)</th>
<th>FEMALE %BW</th>
<th>MALE %BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>10.80</td>
<td>11.18</td>
<td>16.43</td>
<td>13.91</td>
</tr>
<tr>
<td>C</td>
<td>10.24</td>
<td>11.22</td>
<td>15.60</td>
<td>13.95</td>
</tr>
<tr>
<td>N</td>
<td>8.68</td>
<td>8.70</td>
<td>13.20</td>
<td>10.92</td>
</tr>
</tbody>
</table>

*p=0.225

*p=0.009

(Orr et al., 2016)
ABSOLUTE VS RELATIVE LOADS

• The LEO study found female officers carried the same absolute loads compared to the male officers.

• However, when expressed as a percentage of their body weight, female officers carried significantly more relative load than male officers.

(Orr et al., 2016)
CURRENT CONTEXT – AUSTRALIAN LEO (TOU)

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute load carried (kg)</td>
<td>22.8 ± 1.8</td>
<td>20.6-25.6</td>
</tr>
<tr>
<td>Relative load carried (%BW)</td>
<td>25.9 ± 4.0</td>
<td>21.2-28.8</td>
</tr>
</tbody>
</table>

(Carbone et al., 2014; Carlton et al., 2014)
SEX DIFFERENCES IN LC INJURIES


• Mean ARA population over 2 years = 24,876 personnel
  • Female n= 2441 (10%): Male n= 22435 (90%)

• 401 reported injuries associated with load carriage
  • Female n=40 (10%): male n= 361 (90%)
  • RR = 1.02 (95% CI 0.74 to 1.41)

• SPI
  • Female n=6 (15%): male n= 23 (6%)
  • RR of SPI = 2.40 (95% CI 0.98 to 5.88)

https://bond.edu.au/tru
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• Decrements in performance:
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• Reduced performance
  • Survey of 218 soldiers on operations

(Orr et al., 2013)
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• Distance to centre of target
  • DCOT
• Horizontal shot spread
  • X-Dispersion
• Vertical shot spread
  • Y-Dispersion

Carbone et al., 2014
• Mobility Task

Carbone et al., 2014
IMPACTS ON PERFORMANCE - MARKSMANSHIP

- Marksmanship

Carbone et al., 2014
IMPACTS ON PERFORMANCE - MARKSMANSHIP

- No significant difference when TL

Orr et al., Unpublished

Table 1. Primary weapon marksmanship results from all four conditions

<table>
<thead>
<tr>
<th>Task &amp; Loading Condition</th>
<th>DCOT (mm)</th>
<th>X-Dispersion (mm)</th>
<th>Y-Dispersion (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Forward Movement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigues Only</td>
<td>75.93 ± 17.97</td>
<td>112.50 ± 31.35</td>
<td>143.58 ± 44.88</td>
</tr>
<tr>
<td>Tactically Loaded</td>
<td>70.48 ± 19.57</td>
<td>76.42 ± 46.99</td>
<td>168.42 ± 50.39</td>
</tr>
<tr>
<td>Mobility Task</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigues Only</td>
<td>74.83 ± 36.95</td>
<td>116.67 ± 70.05</td>
<td>173.25 ± 139.65</td>
</tr>
<tr>
<td>Tactically Loaded</td>
<td>100.10 ± 20.14</td>
<td>112.50 ± 51.59</td>
<td>213.67 ± 70.99</td>
</tr>
</tbody>
</table>

Data are mean ± standard deviation

Table 2. Secondary weapon marksmanship results from all four conditions

<table>
<thead>
<tr>
<th>Task &amp; Loading Condition</th>
<th>DCOT (mm)</th>
<th>X-Dispersion (mm)</th>
<th>Y-Dispersion (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Forward Movement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigues Only</td>
<td>107.35 ± 37.68</td>
<td>178.33 ± 81.62</td>
<td>206.33 ± 85.87</td>
</tr>
<tr>
<td>Tactically Loaded</td>
<td>112.60 ± 44.37</td>
<td>128.83 ± 59.55</td>
<td>188.25 ± 60.23</td>
</tr>
<tr>
<td>Mobility Task</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigues Only</td>
<td>128.23 ± 33.20</td>
<td>157.00 ± 70.43</td>
<td>274.08 ± 176.61</td>
</tr>
<tr>
<td>Tactically Loaded</td>
<td>108.70 ± 52.48</td>
<td>176.25 ± 70.13</td>
<td>212.08 ± 131.60</td>
</tr>
</tbody>
</table>
IMPACTS ON PERFORMANCE - MARKSMANSHIP

- Visual Analogue Scale (VAS)

Orr et al., Unpublished
IMPACTS ON PERFORMANCE - MARKSMANSHIP

- Perceived significant improvement in marksmanship when TL
  - Primary – VAS +3.00 ± 2.53 (p = 0.016)
  - Secondary – VAS +2.83 ± 2.93, (p = 0.039)

- Correlations between perceptions of load carriage impacts on performance and actual marksmanship scores
  - Primary: Short move: r = -0.347, (p = 0.500) and mobility task: r = -0.401 (p = 0.431)
  - Secondary: Short move: r=-0.631 (p = 0.179) and mobility task: r = -0.306, (p = 0.555)

Orr et al., Unpublished
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• GD police (n=11)
  • Average marksmanship scores (p=.118)
  • ILAV B – smallest SD,
    • ILAV A: a negative impact, -2.1 (95% CI -5.5 to +1.3)
    • ILAV B: a positive impact, +2.7 (95% CI +0.4 to +5.0)
    • ILAV C: a negative impact, -1.7 (95% CI -4.4 to +0.9)
    • Normal station wear: a positive impact, +1.4 (95% CI -2.2 to +5.0)

Schram et al., unpublished
Schram et al., unpublished

![Box plot graph showing the distribution of score across different ILAV categories.](https://bond.edu.au/tru19/08/2019 28)
IMPACTS ON PERFORMANCE - MOBILITY

• Decrements in performance:
  • ↓ Mobility
  • Impeded mission success (Breen 2000)
IMPACTS ON PERFORMANCE - MOBILITY

- Victim Drag (10m)
- Police Vehicle Exit and Sprint

<table>
<thead>
<tr>
<th>Condition</th>
<th>Victim Drag</th>
<th>Vehicle Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILAV A</td>
<td>5.74±0.28</td>
<td>3.49±0.94</td>
</tr>
<tr>
<td>ILAV B</td>
<td>5.47±0.23</td>
<td>3.41±0.87</td>
</tr>
<tr>
<td>ILAV C</td>
<td>5.50±0.38</td>
<td>3.40±1.06</td>
</tr>
<tr>
<td>N</td>
<td>5.56±0.43</td>
<td>3.41±0.85</td>
</tr>
</tbody>
</table>

Schram et al., unpublished
## IMPACTS ON PERFORMANCE - MOBILITY

Carlton et al., 2014

<table>
<thead>
<tr>
<th></th>
<th>Unloaded</th>
<th>Loaded</th>
</tr>
</thead>
<tbody>
<tr>
<td>10m sprint (sec)</td>
<td>2.40 ± 0.22</td>
<td>2.46 ± 0.15</td>
</tr>
<tr>
<td>10m dummy drag (sec)</td>
<td>6.89 ± 0.44</td>
<td>7.79 ± 0.75*</td>
</tr>
<tr>
<td>Total time (sec)</td>
<td>9.29 ± 0.53</td>
<td>10.25 ± 0.77*</td>
</tr>
</tbody>
</table>

* Indicates statically significant differences between unloaded and loaded, p<0.01.
ENCAPSULATION

• Loads for both LEO and Army are increasing
• Female soldiers carry lighter absolute but similar relative loads
• Female LEO carry similar absolute but heavier relative loads
• There are differences in injuries sustained based on sex
• There are different impacts of load on marksmanship (primary / secondary weapon)
• Soldiers think load reduces marksmanship, LEO varies but appear accurate
• Load impacts on mobility – but the load may need to reach a threshold
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References avail on request from tru@bond.edu.au

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Department of Defence
Science and Technology

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